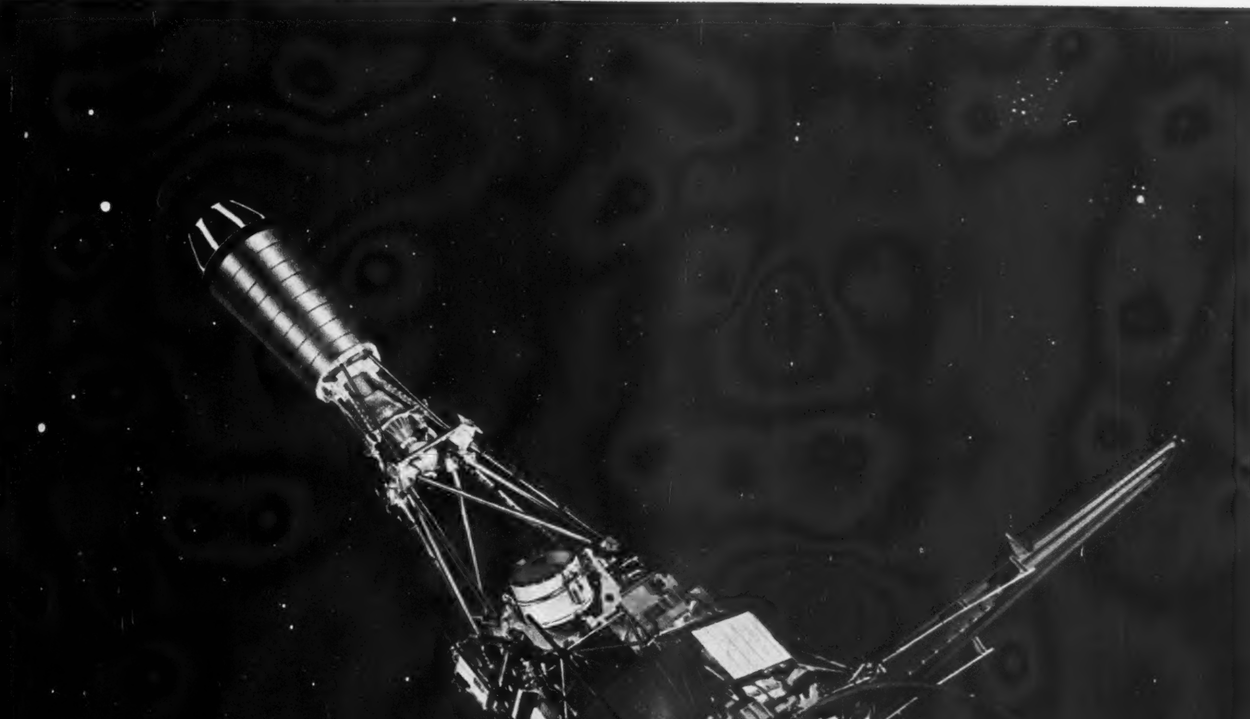
Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

SEPTEMBER 1961



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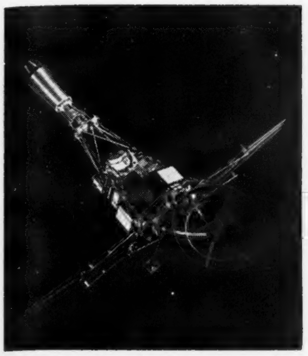

COVER: "Toward the Moon," a photo of the Ranger vehicle superimposed on a rendering of the heavens, courtesy of Jet Propulsion Laboratory. (ASTRO cover plaques, 11 x 12 in. in size, are available from ARS Headquarters at $2.00 each.)

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A PUBLICATION OF THE AMERICAN ROCKET SOCIETY INC.

Vol. 6 No. 9 September 1961

EDITORIAL

RANGER

ARS NEWS

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Astro notes

MAN IN SPACE

• With machine-like precision, the Russians executed their second spectacular manned space shot. Maj. German Stepanovich Titov, 26, carried out 17-plus circuits of the globe in an orbit virtually identical to the single orbit of his predecessor, Maj. Yuri Gagarin. Launched at 9 A.M. (Moscow time) on Aug. 6, Titov's two-stage booster injected his 10,430-lb Vostok II into 88.6-min orbit with an apogee of 159 mi., a perigee of 111 mi and an orbital inclination of just under 65 deg. Titov returned to the earth 25 hr and 18 min after his launching, evidently in excellent physical condition despite his prolonged period of weightlessness.

• Titov, who called himself "Eagle," broadcast greetings to all the continents as they rolled beneath him. His program included manual control of his craft in space, calisthenics, observations through a five-power optical instrument, more than 8 hr of sleep and several meals. His landing site was said to be "near" that of Gagarin, although calculations indicate it was at least 150 mi. to the east. Titov ejected himself from Vostok II after re-entry and made a safe landing by personal parachute in a ploughed field, the spacecraft landing nearby on its own parachute.

• Somewhat short of perfection was the 16-min., 303-mi. flight of Capt. Virgil Ivan Grissom, 35, the second U.S. astronaut to ride into space aboard the Redstone rocket. Grissom's flight on July 21 was a carbon copy of Comdr. Alan Shepard's to the landing, but seconds before a Navy helicopter was to attach its cable to the capsule and raise it partly from the water to allow Grissom to emerge, the side hatch blew away. Grissom hurled himself out as the capsule was flooding. The capsule, Liberty Bell 7, sank in 17,000 ft of ocean, and Grissom himself was plucked from the water only moments before his spacesuit flooded with water through an open air hose connection.

• The Navy was roundly criticized for failing to provide the more powerful twin-engine HR2S Sikorsky helicopter for the capsule recovery mission instead of the smaller HUS-1. The sailors indignantly replied that the astronauts themselves had specified use of the latter machine, with its downwind of 40 knots, in place of the larger helicopter with 85 knots downwind. They suggested the real problem was the hatch, but McDonnell and NASA engineers were unable to pinpoint the cause of the hatch explosion. The 70 explosive bolts of the hatch were fired by a primacord train activated by a percussion cap insensitive to heat, accidental vibration or radio frequency energy. And Grissom staunchly maintains he did not brush against the detonator plunger after removing the safety pin.

• Winding up 27 yr in the AF last month was Brig. Gen. Don Flickinger, chief adviser on bioastronautics for the Air Force Systems Command. It was "Flick" who spearheaded a strong USAF project for a manned space capsule in 1958. This involved a two-ton capsule to be orbited by the Atlas-Agena-A by early 1960. Designated MISS (man in space soonest), it was to be followed in the 1961–63 period by MISSOPH (man in space sophisticated). The latter involved a 6000-lb capsule to be launched by Atlas-Agena-B and a 9000-lb capsule to be orbited by Atlas-Centaur. When the manned space mission was assigned to NASA, Flick's two-ton capsule proved to be too large for the Atlas booster alone and NASA designed its own Mercury system. Although the target dates assigned to MISS and MISSOPH appear quite optimistic in retrospect, it is apparent that these systems would have offered considerably greater growth capability than the 2500-lb Mercury. Furthermore, assignment of this mission to NASA gradually extinguished AF interest in Gen. Flickinger's ambitious bioastronautics program, which called for a total of eight animal shots. As of this moment, the U.S. has not even recovered an organism as complex as a bug from orbit.

• Houston, Tex., appeared to have the inside track as the site for NASA's proposed $60 million Space Flight Laboratory. Although powerful pressure was being put on NASA by Florida, California, Colorado, and Virginia (Hampton is the present site of the Space Task Group in charge of the Mercury project), the Houston area was mentioned most prominently. It was not deemed coincidental that this was the district of Rep. Albert Thomas (D., Tex.), Chairman of the House Independent Officers Appropriations Subcommittee.

• NASA invited 12 U.S. companies to submit proposals by Oct. 9 for development of the Apollo lunar spacecraft system. Companies invited to participate were Boeing, Chance-Vought, General Dynamics, Douglas, GE, Goodyear Aircraft, Grumman, Lockheed, Martin, McDonnell, North American, and Republic. The design calls for a jet-

Box Score on Manned Space Flight

Performance	Gagarin	Shepard	Grissom	Titov
Date	April 12	May 5	July 21	Aug. 6
Type of flight	Earth orbit	Suborbital	Suborbital	Earth orbit
Altitude (mi)	203	115.696	118	159
Distance (mi)	25,000	302	303	435,000
Flight time	108 min	15 min	16 min	25 hr 18 min
Top speed (mph)	17,400	5100	5280	17,750
Vehicle name	Vostok I	Freedom 7	Liberty Bell 7	Vostok II
Period of weightlessness	89.1 min	5 min	5 min	$24^1/_2$ hr (est.)
Weight of craft (lb)	10,395	4031.7	4040	10,430

A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.

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tisonable escape tower like that used on the Mercury capsule and aerodynamic tabs on the Apollo to provide some directional control during re-entry. The specifications called for a living compartment measuring 13–15 ft in diam and 12 ft high. The initial Apollo-A spacecraft is limited to a weight of 10 tons, the maximum payload capability of the Saturn C-1. The Apollo-B lunar orbiting capsule will use the 3-million-lb-thrust Saturn C-3, while the Apollo-C lunar-landing system will require a Nova-class rocket using either solid or liquid propellants.

• Guidance and navigation system of the Apollo spacecraft is to be developed by MIT under a $4 million NASA contract now being negotiated. MIT has been working on a study of the Apollo guidance system for seven months, NASA said. Under the contract with the Space Task Group, it will design and develop Apollo guidance with production responsibility to be assigned to an industrial concern.

PROPULSION

• With AF design contracts for the solid version of the Nova booster close at hand, the battle of the static tests picked up in vigor. Aerojet announced the successful firing of a three-segment 55-ton solid motor at a thrust rating of almost 500,000 lb. Soon after, United Technology announced an 80-sec test of a conical three-segment motor containing almost 40 tons of propellant at a thrust rating of 250,000 lb. The AF target is a 375-ton segmented solid with a thrust of 2–3 million lb which may be arranged in a cluster to produce as much as 25 million lb takeoff thrust.

• NASA and AEC negotiated a $6.3 million contract for the initial phase of the Rover nuclear rocket development program with Aerojet. The first phase of work will involve preliminary development of the Nerva engine, conduct of reactor tests with AEC, assistance in the design of test facilities, R&D on the engine pumping system, control system, nozzle, bearings and seals, and mechanical testing of core components. Nuclear portions of the Nerva job will be conducted by Westinghouse under subcontract to Aerojet.

• An idle ordnance plant at Michaud, La., is a hot prospect to become the manufacturing site for the Saturn C-1 booster. NASA was scheduled to hold a bidder's conference last month for the S-1 eight-engine Saturn cluster, which must be moved out of Huntsville to make room for the Nova hardware project. Michaud, near New Orleans, might also win manufacturing assignments for the Saturn C-3 (using two F-1 engines totaling 3 million lb of thrust) and the Nova booster. Powerful backers of Michaud for the Saturn assembly job are Rep. Overton Brooks, Chairman of the Science and Astronautics Committee, and Rep. F. Edward Hebert, Chairman of the Armed Services Investigating Subcommittee.

• NASA selected RCA's Astro-Electronics Div. to design, build, and test seven ion engine capsules, three for ground tests and four for actual flight tests. Initial flight is scheduled late in 1962 aboard a Scout rocket. A Hughes cesium-ion engine and a NASA mercury-ion engine will be carried in this flight. They will operate for approximately 1 hr of ballistic flight at power levels of 1–2 kw.

• United Technology reported successful tests of a thrust vector system for a large solid-propellant rocket motor utilizing the principle of liquid injection into the rocket nozzle under command of the guidance system. The fluid (which was not identified) causes the exhaust gases to change directions as long as it is forced into the nozzle.

• Rocketdyne conducted a series of thrust build-up tests for the 1.5-million-lb-thrust F-1 engine at Edwards AFB, Calif. Eventual goal of the complete engine is 2.5-min firing time. As many as eight F-1 engines might be clustered to provide a Nova booster for the lunar-landing program in the event NASA decides to go the liquid route in designing the rocket vehicle.

• Initial test flight of the Saturn S-1 stage with two dummy upper stages is scheduled at Cape Canaveral in October. The booster and a dummy upper stage were hauled to Cape Canaveral aboard a converted Navy barge called Compromise which picked up the cargo on the downstream side of Wheeler Dam. (A lock collapse trapped the original barge Palaemon on the upstream side of the lock.)

• Atlas-Centaur was scheduled for its first flight test in November. It will be a ballistic shot, with the Centaur engines driving the second stage back into the atmosphere.

SPACE TECHNOLOGY

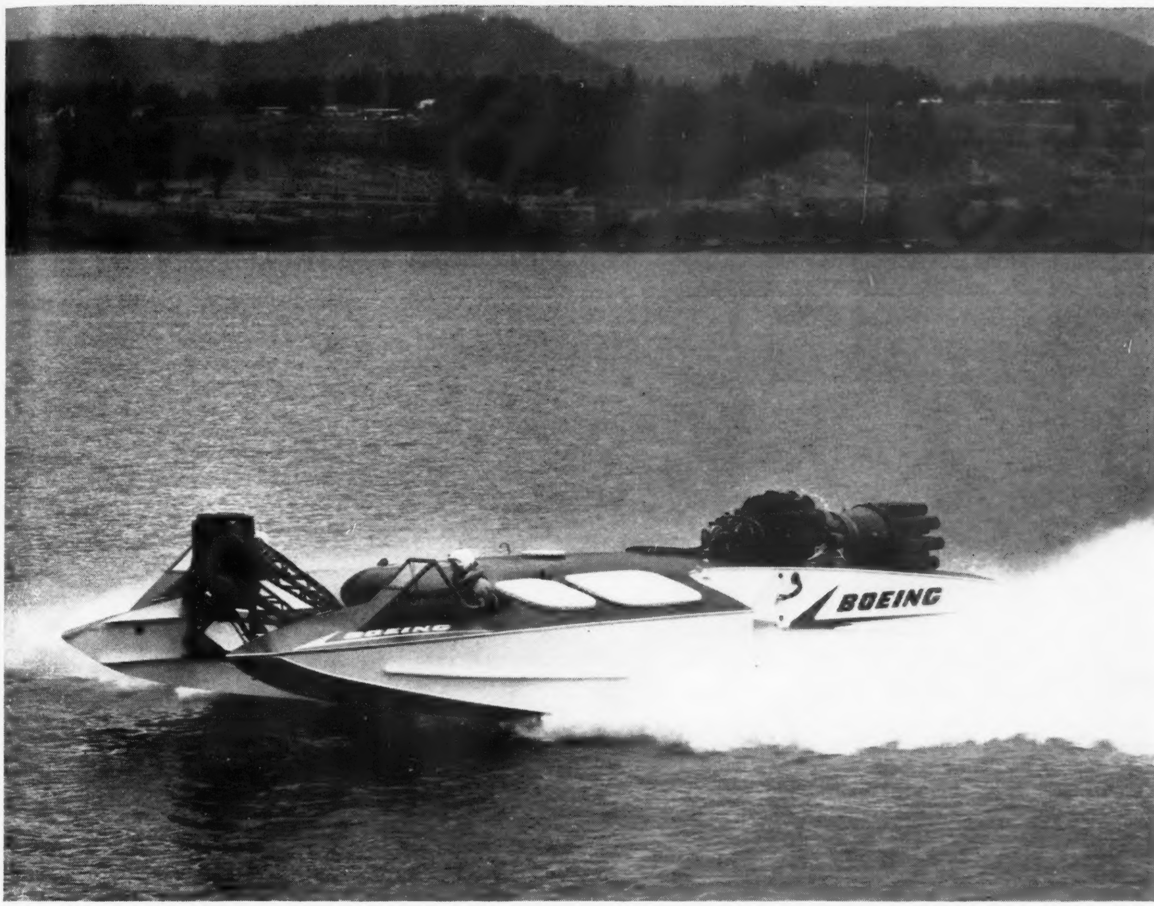
• Bendix Corp., Ann Arbor, Mich., was awarded an $8 million contract to develop a rocketborne communication system capable of transmitting emergency commands to outlying AF bases and airborne bombers. Based on earlier research conducted by the WADC and Hughes Aircraft, the rocketborne system will be designed to transmit signals in the microwave portions of the spectrum which will be relatively unaffected by large-scale ionization from nuclear weapons. The Argus atomic tests over the South Atlantic in 1958 demonstrated that high-frequency channels might be wiped out for prolonged periods as a result of bomb effects at high altitude. The Bendix system, designated 480L, will assure that SAC receive attack orders despite loss of normal communication channels.

• NASA may re-schedule a Mariner "flyby" of Mars to 1962 as a result of increased funding for JPL. NASA originally planned only a Venus attempt for the 1150-lb Mariner in 1962, but increased funds may also permit a Mars shot next year. The chief factor in a 1962 Mars attempt is the availability of the Centaur booster, which has not yet had its initial test flight.

• Hoffman Electronics reported development of a solar cell 15% more efficient than older types by virtue of its greater sensitivity in the blue region of the optical spectrum. The company said the new cell will deliver as much as 10 w per square foot compared with 8.5 w for conventional cells. Hoffman credited the advance to the development of a solar space simulator which mingles light from a xenon tube with that from a tungsten lamp to approximate solar radiation.

• The Applied Physics Lab of Johns Hopkins has developed a circuit tester so sensitive that it can test explosive circuits without danger of triggering them. The APL device consists of two small incandescent electric lights which shine on a silicon cell; current from the latter would have to be 300 times more powerful to set off explosive circuits. The device has been used successfully in checkouts of Polaris weapons assigned to the USS George Washington.

• Atlantic Research has received new orders for sounding rockets. ONR gave ARC a $900,000 contract to manufacture Arcas, a solid rocket capable of carrying 12 lb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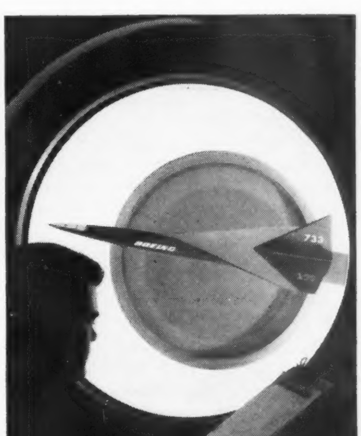

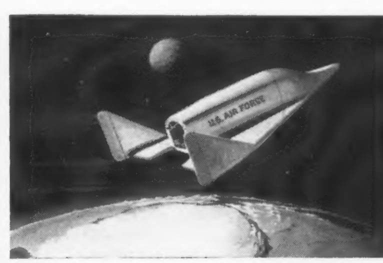

to 40 mi. and lighter loads to 60 mi. ARC also received a contract to build four Iris rockets for the AF by Jan. 1962. A 20-ft rocket, Iris will be capable of lifting 100 lb to 200-mi. altitude.

• NASA's Goddard Space Flight Center gave Minneapolis-Honeywell a design contract for a new Space Environment Facility at Greenbelt, Md., to be used for tests of large spacecraft like the Orbiting Geophysical Observatory and the Orbiting Astronomical Observatory. The facility will include a dynamic test chamber for balancing, spinup, solar-paddle erection, and other mechanical operations in vacuum conditions, and a space environment simulator with a multistage pumping system to achieve hard vacuums and a temperature control system to achieve the intense direct heat of solar radiation. Both chambers are to be ready by Oct. 31, 1962.

• Rocketdyne has invested almost $200,000 of its own funds in preliminary development of a new series of restartable, throttleable space engines with applications ranging from attitude control of satellites to final stage propulsion of lunar-landing vehicles. Rocketdyne has demonstrated a small engine with a thrust variable from 0.1 to 500 lb. Designated SE-1, it uses nitrogen tetroxide and hydrazine propellants and features a radiation-cooled nozzle. The SE-2 is to have thrust ranging from 10 to 10,000 lb, and the SE-3, 5000 to 30,000 lb. Such auxiliary control rockets are expected to play a major role in AF plans for maneuverable space vehicles, including Saint-type anti-satellite systems as well as evasion countermeasures in U.S. obervation satellites of the Midas and Samos types.

COMMUNICATION SATELLITES

• President Kennedy acted on July 24 to set guidelines for commercial development of communications satellites by private enterprise. Following this declaration of national purpose in the communications field, action was swift. The FCC issued a Memorandum Opinion implementing the President's policy statement, and, within a week, NASA had signed a contract with AT&T to launch at least two of that company's experimental active communications satellites during 1962, with launching costs to be paid by AT&T.

• All technical information developed by the AT&T experimental satellites will be made available not only to NASA, but also to other members of the joint venture of international communications common carriers which will operate the U.S. end of the worldwide network.

• Beginning next April, AT&T will conduct at its own expense experiments with active communications satellites which will test the life expectancy of electronic equipment in space. Communications agencies abroad will cooperate in those experiments and will pay for necessary ground stations and equipment.

• After the experimental phase is complete, a full commercial system should be established, that would be owned and operated by all interested U.S. international communications common carriers, under government regulation, in partnership with the international communications agencies of foreign governments. All present and future U.S. international common carriers would be free to use the system to provide services authorized by the FCC.

• Equipment for the system would be obtained on a competitive basis from the aerospace equipment companies and other suppliers. Rockets and launching services also would come from private suppliers, under appropriate arrangements with the government.

• After winning White House blessing of private operation of the communication satellite system and receiving a go-ahead from the FCC for the development of a joint-venture arrangement limited to international common carriers, AT&T quickly found itself faced with some major stumbling blocks. Lee Loevinger, assistant attorney-general for anti-trust activities, said the Justice Dept. was considering action to force AT&T to relinquish its overseas business. If this plan were carried out, it would prevent AT&T from participating in the joint venture and would probably force expansion of the joint-venture plan to include equipment manufacturers, such as GE, who want to share in ownership of the system.

• The patent situation in the active communication satellite field has become a tangled jungle of sharply conflicting arrangements. At one end of the spectrum is AT&T, which had to yield to NASA all of its rights in inventions made as part of its company-financed program to orbit two repeater satellites. Not only did AT&T give up all inventions growing directly out of its own satellite program, but it also gave NASA a license to all patents obtained independently by the Bell systems on inventions calculated to advance the art of satellite communications. By contrast, Bendix and GE, which are developing the Advent synchronous equatorial relay satellite for the Army, retain title to all inventions they accumulate in the course of their government-financed work. Somewhere in between is RCA, which is developing the Relay system for NASA. All inventions made in the course of its work on Relay belong to NASA, but this does not include communication satellite inventions made independently.

• Although superficially similar, the AT&T and RCA repeater satellites differ considerably in design philosophy. The RCA Relay is the more conservative of the two. Equipped with two transponders and a traveling wave tube of 10-w output, it will receive ground signals on 1725 mc and re-radiate at 4170 mc. The AT&T satellite will have a single transponder and a 3-w traveling wave tube to receive ground signals on 6390 mc and transmit at 4170 mc. Both satellites will be launched by Thor-Delta rockets, with the Relay achieving a somewhat larger orbit (900-mi. perigee, 3000-mi apogee) by virtue of its lighter weight, 100 lb against 125 lb for the Bell satellite.

• The U.S. has decided to push ahead with Project West Ford despite objections by some radio and optical astronomers that the project might interfere with their observations. Purpose of West Ford is to study the radio relay possibilities of approximately 350 million hair-like copper dipoles distributed into an orbital belt at approximately 2000-mi. altitude. In a policy statement, the U.S. promised that it would not place additional dipoles in orbit until after a thorough evaluation of West Ford's effects. The experiment was proposed by W. E. Morrow and D. C. MacLellan of the Lincoln Laboratory of MIT, who plan to use only 75 lb of dipoles for their initial studies at 8000 mc. Operational belts might require several tons of dipoles in a polar orbit at 3000 to 4000 mi.-altitude.

• NASA is negotiating a $4 million contract with Hughes Aircraft to develop an experimental narrow-band communications satellite to be placed in a 22,300-mi. equa-

torial orbit late in 1962. Called Syncom, the 50-lb package would be able to relay telephone and telegraph transmissions between the U.S. and Europe, but it could not manage television. Unlike precise station-keeping satellites like the Army's 1500-lb Advent, Syncom would describe a "figure eight" pattern extending 33 deg north and south of the equator, but confined to about 75 deg west longitude. Syncom would pick up ground signals at 8000 mc and relay them earthward at 2000 mc.

SATELLITES

• The Russians blasted both the Tiros III meteorological satellite and the Midas III early-warning satellite as acts of espionage and aggression. "A spy is a spy no matter at what height it flies," declared Red Star, which compared the satellites to the U-2 reconnaissance aircraft. NASA Administrator James Webb came to the defense of Tiros, which he insisted had no surveillance capability. AF maintained a stern silence on Midas III. With the publication of the satellite's orbital parameters, however, it appeared likely that the Russians might find Midas particularly galling. It was placed into a circular retrograde orbit at 2100-mi. altitude with a period of 161.5 min, so that it completed almost exactly nine circuits of the earth each day. One of the properties of this orbit is that it brings the satellite over the Russians' Tyura Tam launching site about dusk every evening (at least for the first several days), giving it a grandstand view of any Red activity.

• One of the two wide-angle cameras in Tiros III failed inexplicably and the other was passed into full-time service. The malfunction occurred on the 170th orbit, after the camera had obtained 2020 high quality pictures of the earth's cloud cover. RCA engineers hoped that the firing of the first pair of spin-up rockets might shake loose any mechanical bug in the system, but the desired result did not come to pass.

• After two successful recoveries of Discoverer capsules (XXV and XXVI), AF stubbed its toe twice in subsequent attempts with the research satellite system. Discoverer XXVII was destroyed by the Range Safety Officer when it veered off course, and XXVIII fell in the South Pacific when the Agena-B stage failed to achieve orbital velocity.

• NASA scheduled another attempt to launch Ranger I late last month. The 675-lb satellite was to be launched by an Atlas-Agena-B into a 58-day earth orbit with an apogee of 685,000 mi. and a perigee of 37,000 mi. The first fully-oriented U.S. space probe, Ranger is the precursor of NASA's first lunar hard landing, expected next year. A key part of the Ranger system is a logic unit containing 10 commands which are issued the satellite as a function of elapsed time after launch. Its major scientific experiments include radiation counters and detectors, a magnetism experiment and an ultraviolet telescope prepared by NRL to look for the earth's hydrogen geocorona.

BUDGET

• Congress voted NASA $1,671 million for fiscal 1962, a cut of about 6% in the agency's request for a down payment on the U.S. lunar-landing program. The reduced amount was voted by the appropriations committees of the two houses following authorization of the total NASA request, $1,784 million, by the House and Senate space committees. Bulk of the reduction, $75 million, was lopped from NASA's research and development request, with $21 million cut from salaries and expenses and $17 million from construction of new facilities. The agency was voted a total of $964 million for fiscal 1961.

• The Pentagon won a record peace-time appropriation of $46,662,556,000 for fiscal 1962, including the last minute $3,500,000,000 asked by President John F. Kennedy to buttress U.S. limited war capabilities to meet the Berlin crisis. The appropriation was $265,000,000 in excess of the Administration's total funds request. It included $525,000,000 for continued output of the B-52 and B-58 bombers, and $180,000,000 to accelerate the B-70 (both resisted by the White House), but these increases were partially off-set by a 2% slash in military procurement funds ordered across-the-board.

R&D

• Approximately $40 million has now been subcontracted by Air Force prime, the Boeing Co., to support the development of the Dynasoar manned space glider. The money—each contract worth at least $1 million—went to eight major concerns. Scores of second-tier suppliers throughout the country say Boeing, plus hundreds of others indirectly involved, are expected to share in the Dynasoar business. The major subcontractors and their jobs:

Chance Vought, Dallas, Tex.—ceramic nose cap.

Electro-Mechanical Research, Inc., Sarasota, Fla.—test instrumentation subsystem, airborne ground equipment for receiving, displaying, recording, and processing data.

Garrett AiResearch Mfg. Div., Los Angeles, Calif.—hydrogen-cooling system for environmental control.

M-H Aeronautical Div., Minneapolis, Minn.—flight-control electronics subsystem for automatic or manned commands.

Sunstrand Corp., Denver, Col.—gaseous hydrogen and oxygen accessory power unit, consisting of reaction chamber, prime mover, gear box, hydraulic pump, etc.

Thiokol-Elkton, Md.—solid propellant motor for escape during launch or acceleration after main-stage burnout.

TRW, Cleveland, Ohio—reaction controls to stabilize glider.

Westinghouse, Lima, Ohio—generator and control unit for electrical power.

• An 8-ft-diam space chamber 18 ft long, instrumentation, and a closed-loop liquid-metal heat-transfer system that will operate at temperatures up to 1500 F will be built at NASA-Lewis for developing space radiators and condensers. Pratt & Whitney's Connecticut Aircraft and Nuclear Engine Lab (CANEL) will design and build the installation during the next year under a $589,000 contract . . . United Nuclear Corp. will also design and build for Lewis a 1000-kw liquid-metal heat-transfer loop for studying potassium and sodium as turbogenerator working fluids at continuous operating temperatures up to 2200 F, conditions requiring use of refractories such as niobium . . .

• Electro-Optical Systems will develop a solar thermionic converter weighing about 25 lb and capable of serving as the main power source on Mariner-class space vehicles for NASA-JPL under a $318,303 contract. Designed to generate 135 w at 40% of the solar flux on the earth's surface, the converter will employ a mirror about 5 ft in diam focused on an array of cesium-cell thermionic diodes in a cavity. A prototype is due in less than six months. ♦♦

For the record

The month's news in review

July 5—Israel fires meteorological rocket, Shavit II, to 50-mi. altitude.

—West Germany agrees to participate in the European Organization for Space Research.

July 7—Atlas-E is shot to record 9050-mi.

—Discoverer XXVI launched into polar orbit, capsule snared in mid-air after re-entry.

July 9—NSF study urges treble investment in education and research in universities to meet scientific needs of next decade.

July 10—Midas III fails to lift off pad.

July 12—AF launches Midas III and Tiros III into orbit.

July 13—Navy successfully fires Polaris over Atlantic range in test of new guidance system.

July 19—Senate-House conference committee approves full $1,784 million requested by President Kennedy for space budget for FY 1962.

July 21—Astronaut Virgil I. Grissom rides Mercury capsule to 118-mi. altitude and 303 mi. out into Atlantic. Side hatch is prematurely blown off and capsule later sinks.

—AF picks 50 test pilots as candidates for future military man-in-space missions.

July 22—Federation Aeronautique Internationale recognizes flight marks of Maj. Yuri A. Gagarin and Comdr. Alan B. Shepard Jr. as follows: Gagarin: Duration in orbital flight—108 min; apogee—203 mi.; greatest mass lifted in earth orbital flight —10,395 lb. Shepard: Altitude without earth orbit—115.696 mi.; greatest mass lifted without earth orbit—4031.7 lb.

July 24—Administration policy statement favors private ownership and operation of a global communication satellite network.

July 27—Minuteman successfully fired to about 5000 mi.

July 28—NASA and AT&T sign pact under which AT&T will launch first privately owned communications satellite.

—Aerojet-General and Westinghouse Electric receive NASA-AEC contracts for preliminary work on a nuclear rocket engine.

—NASA invites 12 industrial concerns to submit bids by Oct. 9 on Apollo spacecraft development.

Careers in astronautics

By **Irving Michelson**, *Illinois Institute of Technology*

The optical maser, or "laser," has been widely hailed lately as one of the most important technical developments of the past decade. Despite the fact that the first successful solid-state laser was announced less than one year ago, its value in the space sciences seems to have been immediately seized upon. Applications for long-range communications and detection systems are among the most obvious and several of these developments are now reported to be underway. A sun-powered laser for jam-proof communication over immense distance is one of these, under study at American Optical's research center under AF direction. In the propulsion field, too, high hopes are being pinned on the laser concept as a compact radiator for space engines.

The laser has as big a place in pure physics as well, we are told, since it affords the possibility of performing experiments of great value in quantum electrodynamics. These relate to the study of the interactions of matter with extremely high light intensities. The key element in all of these laser developments has been explained as the production within a cavity of light which is not only very intense but also coherent.

Physics and solid-state science, on the one hand, and applied techniques in areas such as communications and propulsion on the other, thus appear to have much to gain by further efforts in the broad area of coherent collisions. Recent successes are a real tribute to such interdisciplinary endeavors and indicate that scientists and engineers can find many interesting projects in this area.

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From Scotland comes word that astronomers are now planning to photograph the stars with specially designed rocket-borne cameras. The first objective is to determine brightness in the ultra-violet wavelengths, and a camera has reportedly already been designed for this purpose. One of the major problems outstanding is rocket stabilization sufficient to permit the camera to be aimed properly. We strongly suspect that know-how on attitude stabilization techniques already well developed in this country can be of immediate assistance to the Scottish Space Research group, and hope that neither side has overlooked the possibility here.

Space vehicle designers and rocket builders here are also sure to recognize several important and attractive aspects of this development in astronomy. If star photography from rockets becomes standard astronomical technique, a standardized low-cost vehicle would be of great value, and reductions of payload costs will determine the importance of attempting recovery of capsules containing attitude control, photographic, and telemetry packages. Since rocket trajectories for these purposes will be of small horizontal range, desert launching sites can be considered, and these would also greatly simplify the recovery problem.

It is also good to hear that our astronomer friends are turning to tape and punched-card techniques for data handling and reduction, reducing tedium while greatly expediting observation procedures. Star spectra are already being presented in photographic recordings handled by automatic microphotometers with digital output. Thus it appears that the latest methods are by no means unfamiliar at the observatories.

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On the engineering and scientific manpower scene, some statistics of general interest have just been released. These indicate that the number of engineers in American industry is 615,000, while chemists number 72,000 and physicists 15,000. Total scientific and technical personnel in all professional categories are estimated to number 870,000. Although this total continues to grow, the rate of increase has dropped materially in the last several years. It is believed that by 1964 the rate of production of first-degree holding engineers will be at 34,000, which represents a drop of about 10% within five years.

In contrast with this, NSF has reported that Communist Chinese professional manpower pools are being greatly expanded through massive education and training programs. Serious questions are raised about quality, though the large numbers are certainly impressive. In Canada a survey of salaries in engineering and the sciences shows that engineers are now better paid than men in the natural sciences, by a factor of around 9%. In this country again, engineers' strongest attitude reactions have been found to relate to inadequate company recognition of their achievements. More than 80% are reported to feel that changing jobs leads to better professional opportunities and salaries. Also, nearly half (44%) of the 70,000 scientists and engineers at U.S. colleges and universities are engaged in R&D efforts, according to another survey recently completed.

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More and more frequently nowadays we hear of astronautical developments which have come of age, replacing traditional techniques in industrial, commercial, and government activities. The communications satellite is one of these. The FCC has predicted the establishment of satellite communications on an experimental basis in 1963 and commercial operation the following year, including international transmission of telephone calls, of telegraph and other printed messages, and "relay television."

The wealth of day-to-day operational experience with satellites that this would provide is reminiscent of the immense benefits to general aviation a few decades ago, of early experience with air-mail service.

We are also impressed by the Weather Bureau's statement that storm-spotting satellites of the Tiros series have fixed the location of tropical storms more accurately than could be done by conventional means. Probably satellites will soon be standard observation equipment in meteorology, and more sophisticated missions will be devised as more experience is accumulated. For these satellites, as for communication satellites, miniaturization, reliability, and power will be of dominant importance. This makes us wonder if we will be seeing the same vehicles used for both communications and meteorological satellites.

For specific career opportunities, see pages 1, 5, 12, 20, 54, 57, 63, 68, 71, 72, 74, 75, 79, 81, 84, and Fourth Cover.

In print

In "**Victory Over Space**" (264 pp., Little Brown, $4.95), Albert Ducrocq, French astronautical pioneer and scientist, as well as science writer, offers not only an excellent introduction to astronautics but also what is perhaps the first objective comparison of the U.S. and Soviet space programs. American astronautical engineers and scientists, and the industry as a whole, would, for example, find it profitable to read the first chapter on "Astronautic Aims and Achievements," and especially that section of the chapter on pages 21–23 which the author heads "The Inertia of the Rocket Industry." This view of astronautics from abroad provides some thoughtful comments on where we are going and how we will get there, and is well worth the attention not only of those of us who are in the field, but of top government officials as well.

* * *

Two recent books on astronomy which deserve more than just a passing glance are "**The Moon**" by Zdenek Kopal (131 pp., Academic Press, $4.50) and "**The Milky Way Galaxy**" by Ben Bova (228 pp., Holt Reinhart and Winston, $5). In the former, one of the world's leading lunar astronomers provides a full-scale look at "our nearest celestial neighbor," covering facts and figures about the moon, moonlight, the lunar surface and changes on the moon, and winding up with an excellent chapter on lunar exploration, both manned and unmanned. The latter offers an excellent introduction to stellar astronomy for the layman, starting with our neighbor stars and moving out to our own galaxy and beyond. Both volumes are amply illustrated and include some new photos (a rarity in books on astronomy!), although reproduction is poor in the Bova book.

* * *

Atomic physicist Ralph E. Lapp turns his attention to astronautics in "**Man and Space: The Next Decade**" (183 pp., Harper, $4.95), and, while the basic approach is to look into the future rather than to review the past, the net result is little more than just another book on the subject, which can be recommended only because the author writes well and at this point the book is relatively up to date. David O. Woodbury's "**Outward Bound for Space**" (178 pp., Little Brown, $4.50) falls into pretty much the same category. However, isn't it about time publishers stopped putting out "just another book" on astronautics? One would certainly think so.

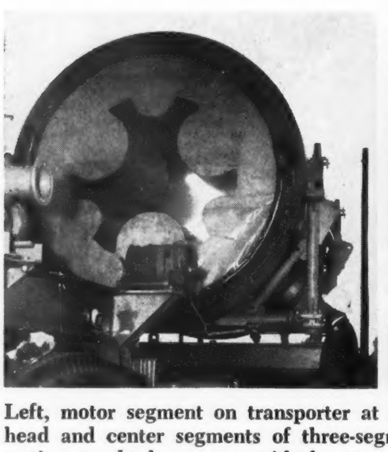
* * *

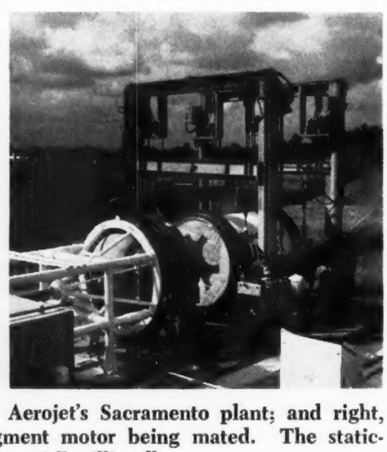
"**Gateway to Space**" by Charles Coombs (256 pp., William Morrow, $3.95) is a puzzling book. Obviously written for youngsters, in a simple easy-to-read style, it nowhere mentions this fact but apparently will be merchandised as an "all-purpose" book on rocketry and astronautics, for both juvenile and adult readers. This is too bad, for, while it is an excellent book for youngsters, it has little to say which has not been said elsewhere, often in greater detail and better, when considered on the adult level. Main subjects covered are the Patrick-Canaveral complex, the large missile, satellites, and space stations, the X-15 and Project Mercury. Most of the illustrations used have already appeared elsewhere, and more than once. Sum-up: A good juvenile, but little more.

Aerojet-General Demonstrates Large Segmented Solid Rocket

The accompanying photos show the three-segment solid rocket developing nearly 500,000-lb thrust successfully static-fired by Aerojet-General last June. The motor weighed 55 tons and measured 8 ft and 4 in. in diameter by 30 ft long.

Plans call for Aerojet to static test a segmented solid motor with approximately 1-million-lb thrust later this year. As of August, Aerojet has received Air Force contracts totaling $5.8 million to show feasibility of segmented solid rockets for multimillion-pound-thrust boosters of the Nova class.





Left, motor segment on transporter at Aerojet's Sacramento plant; and right, head and center segments of three-segment motor being mated. The static-testing stand takes motors with thrust up to 1.5-million lb.

NASA Names T. F. Dixon New Launch Vehicle Director

Thomas F. Dixon, an ARS Fellow Member and president of the Southern California Section, has been appointed director of NASA's Office of Launch Vehicle Programs (OLVP), succeeding Maj. Gen. Don R. Ostrander who is returning to the Air Force as vice-commander, Ballistic Systems Div., Air Force Systems Command. Dixon, vice-president for research and engineering of Rocketdyne Div. of North American Aviation, will assume his duties at NASA Sept. 18. In the interim, Milton W. Rosen, also an ARS Fellow and deputy OLVP director, will serve as acting director.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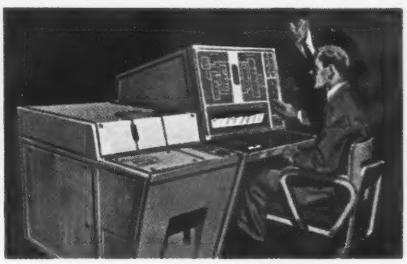


Space—A National Symbol

THERE can be little doubt that the physical, earthbound, and ordinary frontiers of yesterday have been swept away by the new frontiers of space, and that the challenge posed by the conquest of space is the most dramatic event in our lives today. Furthermore, it has become abundantly clear that this challenge is becoming more and more intellectual in nature.

Our only hope for peaceful survival may well lie in our scientific curiosity about space. Scientific achievements in space have become directly related to technological power. The world watches and waits to see which country has the superior scientific capability of harnessing the forces of nature.

The desire to conquer space accelerates our activity in science and technology, and science and technology are important to everything. The conclusion is therefore inescapable: The conquest of space must become a national symbol if the proper attitude of dedication and the proper sacrifices are to be made. Without these, we are doomed to failure.

Certainly no group in this country is more uniquely qualified to establish the conquest of space as a national symbol than the American Rocket Society. It should be the driving goal of ARS to make known to our citizenry the import, potential, and reasons behind a truly dynamic space program. ARS must unhesitatingly become the foremost spokesman for a significant space program in the U.S. today. It must shoulder the burden of relating the role of the space scientist and engineer to all professional men in America, as well as to the entire community. The true meaning and significance of our space program must become clearly understood throughout America.

In order to perform better this gigantic task, ARS must itself move forward in size and posture. A very major part of its stature and position will depend upon the strength of its membership. Although the caliber of our membership today is high, it must be increased in scope as well as in number. In addition, every effort must be made to broaden and deepen our influence. ARS members must accept the challenge and opportunity to truly become the "Voice of America" in space.

As members of ARS we must—all of us—rededicate ourselves to the purposes and objectives described in Article 2 of the By-Laws. They are conveniently reprinted on this page. We must, each and every member, ask ourselves: "What am I doing to promote the best interests of the Society and to achieve its objectives and aims?"

While it is the concern of all of us, it is the *responsibility* of others in ARS to make certain that the quality of the membership remains high, improves, and increases in professional stature, through proper technical committee action, symposia, technical meetings, etc. My official concern on the behalf of the ARS is expressed in my role as chairman of the Membership Committee.

I shall be writing to each member in the very near future regarding the establishment of means for increasing the membership of the Society. If you agree that this is the position we must all take, I urge you to increase your role as a nucleating center in our mission to make space a national symbol and to play your part as intensely as your conscience dictates and your time allows.

A. M. Zarem
CHAIRMAN, ARS MEMBERSHIP COMMITTEE

By-Laws of the American Rocket Society, Inc.

ARTICLE II (Purpose and Objectives)

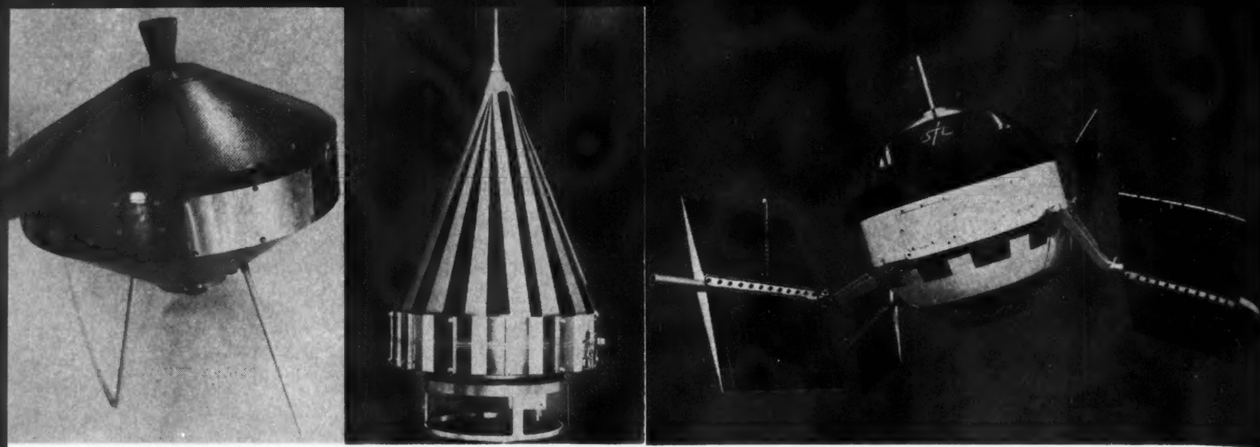
Section 1. The purpose of the American Rocket Society shall be to further by all appropriate means the sound advancement of rocketry and astronautics.

This purpose shall be achieved in such manner and by such methods as may be deemed appropriate by the Board of Directors.

These methods shall, however, include aiding the professional and technical development of those engaged in scientific and engineering disciplines affecting the advancement of rocketry and astronautics; the furtherance of technologies through effective technical communications, and the stimulation of achievement through awards and other suitable recognition for outstanding technical and professional accomplishment.

The Society shall recognize its obligation to aid in the development and improvement of education in rocketry, astronautics and related disciplines.

It shall also recognize an obligation to communicate the value, significance and importance of rocketry and astronautics to the nation at large.



Dramatic harbingers of the U.S. lunar program—left to right, Pioneer I, Pioneer IV, and Pioneer V—contrast sharply in size and complexity with the basic Ranger lunar vehicle, shown opposite. Ranger I weighs 675 lb.

Ranger in the lunar program

Ranger will inaugurate our scientific exploration of the moon with space vehicles, and will build a basic technology for the manned lunar expedition

By Clifford I. Cummings

NASA JET PROPULSION LABORATORY, PASADENA, CALIF.

Clifford I. Cummings is Lunar Program Director at JPL. Since receiving a B.S. in physics from CalTech in 1944, he has held a succession of positions with JPL—project leader for WAC Corporal and Corporal missile telemetering systems and range instrumentation, project leader for Corporal guidance, technical coordinator for the complete Corporal missile, JPL's portion of the Jupiter program, and head of the systems engineering division. In January 1958, Cummings took leave of absence to join DOD's Weapon Systems Evaluation Group, and then in June 1958 to become a member of the ARPA staff. In January 1959, he became JPL's representative at NASA headquarters, and then in June 1959 returned to JPL in his present assignment.

The Ranger articles that appear in this issue of *Astronautics* constitute a general description of the opening phase of the U.S. unmanned lunar exploration program.

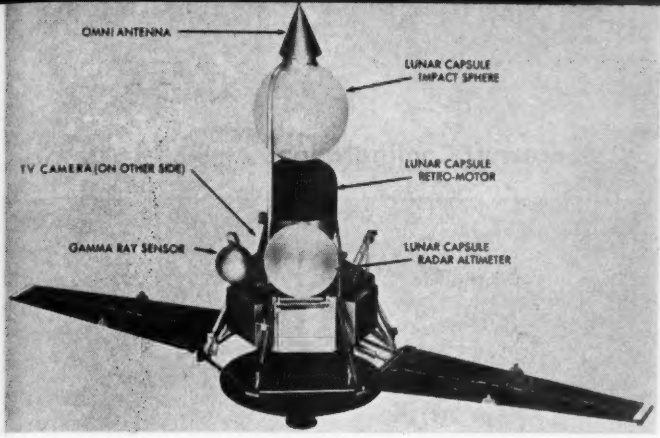
Ranger 1, the first research and development vehicle in the series was launched at 6:04 a.m. (E.D.T.) on August 23 from the Atlantic Missile Range.

At the end of the parking orbit, the Ranger spacecraft was to have been accelerated from orbital velocity (approx. 5 mi. per sec) to close to escape velocity (approx. 7 mi. per sec). This required a velocity increment of approximately 10,500 fps; however, radar data showed that the Ranger was accelerated by only 240 fps.

The consequence was that Ranger 1 was placed in a low earth orbit instead of the planned highly eccentric orbit. Despite being in an environment for which it was not designed, Ranger 1 performed flawlessly. The experiment demonstrated that the United States now has a working spacecraft system and can proceed confidently to the next experiment.

A SHORT review of the lunar-probe attempts during the past three years will help establish the Ranger Project perspective. The first attempts by the U.S. were a series of three lunar probes, using the Thor-Able I combination. The second of these three attempts, Pioneer I, reached an altitude of 70,700 mi. on Oct. 11, 1958.

The next series of two U.S. attempts used the Jupiter and a spinning cluster of solid-propellant rockets which had previously been used on the Redstone to put Explorer I into orbit on January 31, 1958. The first of these shots, Pioneer III, achieved an altitude of 63,580 mi. on Dec. 6, 1958. On March 3, 1959, the second in this series, Pioneer IV, was injected on a path (CONTINUED ON PAGE 52)



Ranger 3, 4, and 5 Spacecraft Configuration

The Ranger spacecraft

It will not only carry scientific apparatus for exploring the moon and solar plasma interacting with earth, but also embody key engineering experiments on lunar and interplanetary space-vehicle design

By James D. Burke

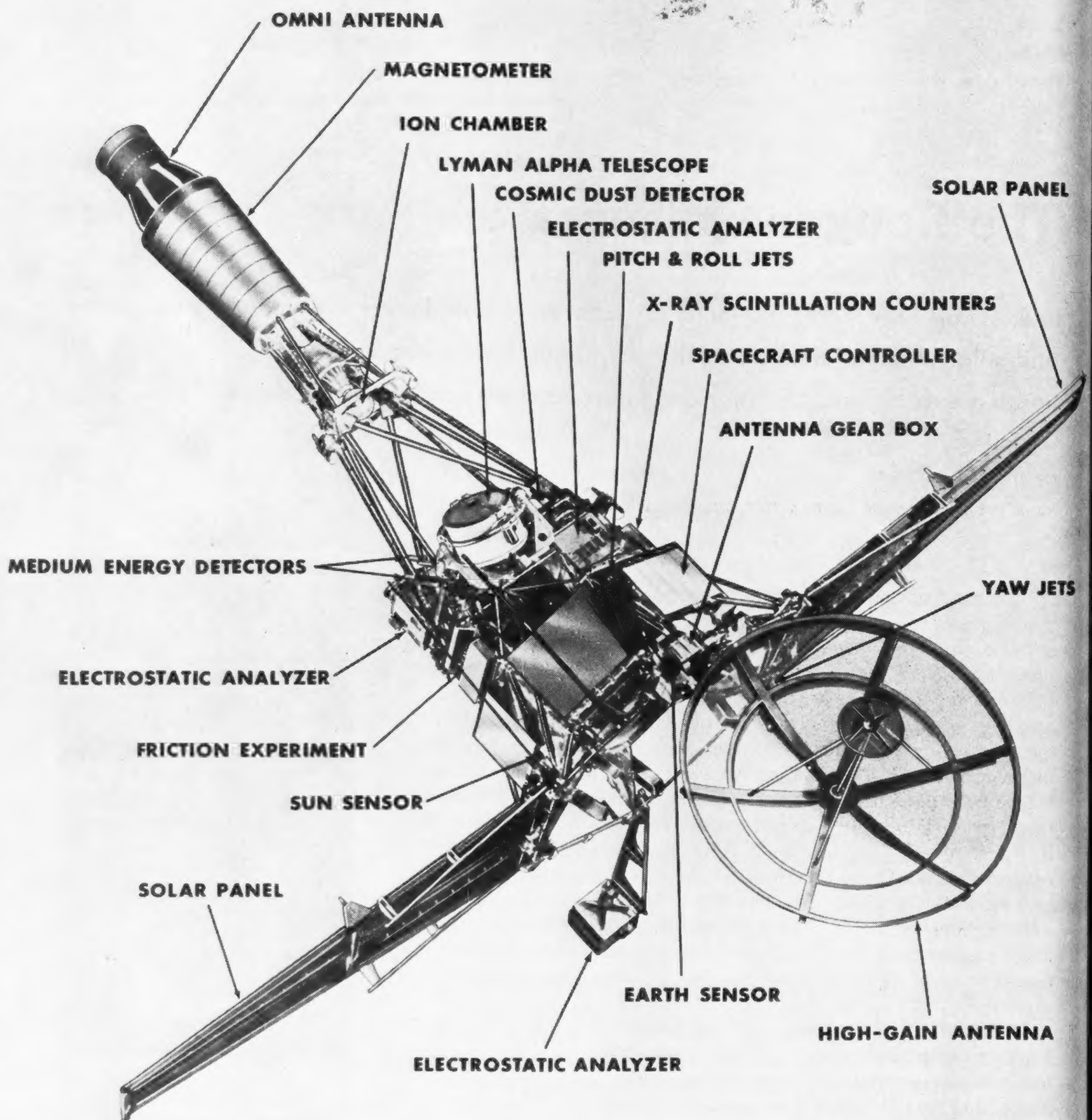
NASA JET PROPULSION LABORATORY, PASADENA, CALIF.

THE RANGER spacecraft shown on this month's cover is the first of a series designed by the Jet Propulsion Laboratory (JPL) for the initial exploration of the Moon. The planned flight program at present consists of five shots, the first two of which are engineering tests and the last three lunar missions. These first five spacecraft are the product of a design effort that began in early 1959, at about the time when the ABMA-JPL team was preparing the Juno II rocket and the 14-lb payload of Pioneer IV, the first U.S. probe to escape from the Earth. The Rangers are enormously more complex than Pioneer IV, yet they are but a small step toward the technology that will be required for the reliable transportation of men and equipment to and from the Moon. It is, nevertheless, instructive to look back now over the development. The Rangers do illustrate some engineering approaches to the problems that will exist in any lunar mission, and they will provide information about the Moon that may be of great value in planning the later lunar-exploration programs.

At the outset of the project, it was known that the spacecraft, launch vehicles, and ground systems required for lunar and planetary exploration would all be very complicated and expensive and, hence, that the number of deep-space launchings would be severely limited. Therefore, the equipment had to be inherently capable of rapid reliability growth. One way to achieve rapid reliability growth is to use a single design repetitively. It was decided to single out the functions that would be common to all flights and to combine the related subsystems into a basic spacecraft "bus" whose

James D. Burke is JPL's Ranger Project Manager, and has been an engineering group supervisor at JPL, in charge of design and investigation of missile systems and advanced applications of missiles. Burke joined JPL in 1949 after receiving M.S. and A.E. degrees from CalTech. He has been a Naval aviator.

Ranger 1 and 2 Spacecraft Configuration



design would vary as little as possible from mission to mission. To this bus would then be added different mission packages bearing instruments characteristic of the particular flight objectives.

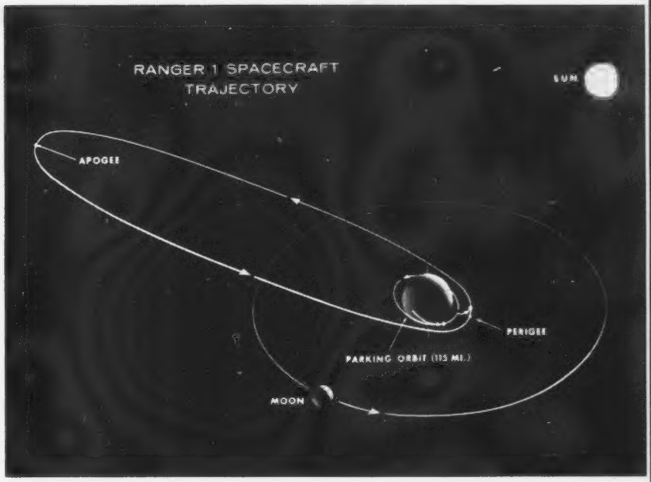
Design studies soon yielded the conclusion that for adequate communications at planetary distances, for the most efficient exploitation of solar power, for accurate trajectory corrections, and for pointing instruments such as TV cameras, the spacecraft must have a system of attitude reference, stabilization, and control. Also, it was evident that there would be a need for accurate and reliable on-board programming devices, and it soon became clear that a radio-command system would be indispensable for controlling the operation of the spacecraft in flight. The guidance-and-control, power, and telecommunication subsystems, together with the requisite structure, electronics packaging, environmental protection, and diagnostic instrumentaion features, make up the basic Ranger bus. The scientific instruments and associated equipment comprise the mission package.

Instrumentation Package Similar

Since there was no way of predicting which of a given series of flights might succeed, it was apparent that it would not be practical to design either the mission packages or the diagnostic engineering instruments for piecemeal or progressive experimentation. Rather, all of the instrumentation packages in a series would have to be nearly the same, and each of them would have to be capable of measuring beyond the expected ranges of all variables, so that any single successful flight would be sure to yield useful data. Redundancy within the instrumentation would be desirable for the same reasons.

A number of other criteria which were applied to the Ranger spacecraft design may appear contradictory to the objectives of the immediate project. For example, most of the equipment is designed to have a lifetime of many months in the space environment, even though the trip to the Moon takes only a few days. This was done to build experience with the techniques known to be necessary for planetary flights. It was decided to employ a completely passive temperature-control system (i.e., surface coatings, and no internal circulating gas or other mechanisms). Such a system is harder to design, but we believe that it would be better to grapple with the problem now, since a solution would be very valuable in the long run.

The Rangers that go to the Moon will be biologically sterilized. Opinions differ as to whether contamination of the Moon by Earth life forms would be a scientific disaster, but there is little doubt that



contamination of Mars would be. Therefore, before sending anything to Mars, we must master the technology of building equipment that not only can meet all of the other stringent demands of a space mission but can also be sterilized before launching by means of heat, radiation, or chemicals. The Rangers provide our best opportunity to develop the requisite techniques.

In the current flight program, two configurations of the spacecraft exist. The first configuration (for Ranger 1 and 2) is shown on the cover and on page 24; the second configuration shown on page 23 will be used in three subsequent flights (Ranger 3, 4, and 5).

Provide Engineering Test

As mentioned previously, the Ranger 1 and 2 flights are intended to provide an engineering test of a simplified spacecraft before lunar-mission attempts. The trajectories for these flights have been chosen to avoid the Moon. The scientific experiments have been selected to take advantage of the engineering-test trajectories, and have nothing to do with the Moon. They are, instead, a diverse but integrated group of experiments on particles and fields in space, which, if successful, will give a uniquely definitive picture of the solar plasma and its interaction with the Earth. The scientific instruments and their sponsors are listed in the table on page 27; the experiments are described in more detail in JPL Technical Report No. 32-55.

The normal flight operating sequence of Ranger 1 and 2 spacecraft is: After separation from the Agena-B launch vehicle, the solar-power panels and the parabolic antenna extend. The attitude-control system then points the (CONTINUED ON PAGE 49)

Early Ranger experiments

Their first and foremost purpose will be to give an extensive, detailed picture of interplanetary plasma

By Albert R. Hibbs, JPL CHIEF, DIVISION OF SPACE SCIENCES

M. Eimer, JPL DEPUTY CHIEF, DIVISION OF SPACE SCIENCES

M. Neugebauer, JPL RANGER 1 PROJECT SCIENTIST

The eight scientific experiments on Ranger represent the work of scientists and engineers at seven institutions: The California Institute of Technology, Goddard Space Flight Center, Jet Propulsion Laboratory, Los Alamos Scientific Laboratory, Naval Research Laboratory, State Univ. of Iowa, and Univ. of Chicago. Scientific aspects of the instrument system were the responsibility of Mrs. Marcia Neugebauer of JPL, project scientist; and Raymond L. Heacock, of JPL, project engineer, was responsible for system engineering.

SOLAR CORPUSCULAR RADIATION EXPERIMENT

This experiment under the responsibility of Mrs. Marcia Neugebauer and Conway W. Snyder, JPL, follows the density and motion of drifting plasma clouds and measures plasma-particle energies. Its electrostatic analyzers are open to space and can collect and measure the lowest energy particles; six detectors point in six different directions.

As a charged particle enters an analyzer, it finds itself in a curving tunnel. The sides of this tunnel are two metal plates carrying opposite static charges. Attracted by one plate and repelled by the other, the particle follows a curved path down the curved tunnel. If it moves too slow or too fast, it runs into one wall or the other. But if it moves at just the right speed, it makes the end, and there a counter detects it.

Automatically, at fixed intervals, the amount of the static charge on the metal side plates changes, allowing a different energy range of particles to get through. The analysis process involves 12 such voltage steps.

In cycling through its voltage sequence, each analyzer will observe four energy ranges of electrons between 13.7 and 110 e.v. and eight energy ranges of protons between 13.7 and 5500 e.v.

To determine whether the particles are streaming outward from the sun as a solar wind, or wandering at random through a comparatively stationary plasma cloud, the most fundamental measurement is a comparison of measurements taken looking toward and directly away from the sun. The two analyzers which make these two measurements are on a boom several feet out from the spacecraft body, away from the effects of any sheath of charged particles which Ranger may accumulate moving through the interplanetary plasma.

The six detectors weigh 33 lb (total) and draw 2.74 w. C. S. Josias and J. L. Lawrence of JPL did the engineering design of this experiment.

MEDIUM-ENERGY-RANGE PARTICLE DETECTORS

Six of these observe charged particles in an energy range overlapping the low energies of particles in the interplanetary plasma and extending upward toward the high energies of fast-moving cosmic rays.

Four are cadmium sulfide detectors not covered by protective tube wall or case. Thus, particles of very low energy can be detected. Protons and electrons with energies greater than 100 e.v. will produce a measureable change in resistance upon striking the detectors. Sunlight also produces such a change, so the detectors are placed behind a series of baffles.

One of these detectors includes a small magnet. An electron with energy below 400,000 e.v. moving toward the detector would be swept aside by this magnet and thus not be counted, whereas much heavier protons will proceed nearly straight on. The other three detectors contain no magnets, and will consequently count both electrons and protons. The four counters are arranged in pairs and point in two different directions, all at about 45 deg to the direction of the sun.

This experiment was developed under direction of James A. Van Allen at SUI. Dr. Van Allen's group also developed another experiment employing a Geiger-Mueller counter similar to those used to detect the radiation belts. This Geiger-Mueller tube will count all protons which have energies above 500,000 e.v. and all electrons with energies above 35,000 e.v. It will count accurately up to a rate as high as 20,000 particles per second.

C. Y. Fan, P. Meyer, and J. A. Simpson of the Univ. of Chicago supply a particle experiment which uses a detector consisting of two thin discs of silicon coated with gold and then placed one behind the other. A proton with an energy greater than 0.5-million e.v. will enter the first disc and produce a shower of ions strong enough for the electronic circuits to register a count. If the proton has an energy less than 5-million e.v., it will not be able to get all the way through the first disc. Particles with energies greater than 5-million e.v. will penetrate into the second disc and cause another shower of ions and a pulse from the second disc. If the energy is even greater than 10-million e.v., it will proceed so rapidly through the first disc that the resulting shower of ions will be too weak to record as a count. Thus, 10-million e.v. is the upper energy limit of the counter. The electronic circuits determine whether pulses come from both discs or just the first one.

This detector has the advantage of being completely insensitive to electrons and X rays, so it will count only the nuclei of atoms.

The total of six medium-energy-range particle detectors weighs 3.8 lb and draws 0.16w. J. Denton Allen and Conway Snyder provided JPL's engineering and scientific support for this experiment.

COSMIC-RAY IONIZATION RATE MEASUREMENT

Primary cosmic radiation and other ionizing radiation are measured by a quartz-fiber integrating-type ionization chamber invented by H. V. Neher, CalTech. A quartz fiber is positioned a short distance from a quartz rod inside a hollow metal shell (chamber). The rod and fiber are charged to the same voltage. As cosmic rays penetrate the wall of the ionization chamber and shoot across the gas inside, they leave a wake of charged ions. Negative ions and electrons drift toward the quartz rod and build upon it a static charge, which attracts the fiber. When enough ions have been produced and have drifted to the rod, and enough charge is built up, the fiber is pulled close enough to touch the rod. This produces an electric pulse which is amplified and telemetered, and at the same time discharges the rod, returning the fiber to its starting position. The time between successive pulses indicates the rate at which cosmic rays are penetrating the wall of the ion chamber. Protons which penetrate must have an energy of at least 10-million e.v. Measurements made with this chamber can be used to interrelate many of the particle counters on the Ranger with many of the cosmic-ray measurements made over the last several decades. Continued use of such ionization chambers will permit future radiation measurements to be compared against an absolute base and data will have a direct bearing on manned spaceflight preparations.

The ion chamber was built by Hugh Anderson and other members of W. S. McDonald's group at JPL. The instrument, which weighs 1.2 lb, requires 4 mw, was calibrated in H. V. Neher's laboratory at CalTech.

TRIPLE-COINCIDENCE COSMIC-RAY ANALYSIS

High-energy radiation is measured by an experiment developed by C. Y. Fan, P. Meyer, and J. A. Simpson of the Univ. of Chicago. It involves two triple coincident telescopes, each consisting of an assemblage of countertubes arranged in the same manner as units successfully flown on Explorer 6 and Pioneer 5. They are cylindrical bundles with six tubes on the perimeter and one centered.

These two cylindrical telescope bundles lie on their sides projecting through the top of one of the equipment boxes in the hexagonal base of Ranger I. In each bundle, the counting tubes are connected in three separate groups: The first group consists of the outer

three tubes, which are exposed to space: the second "group" is the central tube; and the third consists of the three tubes which lie on the bottom of the bundle and actually project into the equipment box. As a charged particle comes through the bundle of tubes, the electronic circuits determine which of the groups the particle has penetrated. When a pulse comes from all three groups at once—a triple coincidence—the particle was undoubtedly a high-energy one rather than an X ray or a low-energy particle. The tubes are very inefficient at counting X rays, and the likelihood is small that an X ray, even if it penetrated all three groups, would cause a detectable pulse in each group.

Such "triple-coincidence events" are telemetered together with single counts from the center tube. By comparing single-count and triple-coincidence data, how many of the counts were due to X rays and how many were due to protons or other high-energy charged particles can be determined.

The two bundles of counters differ in the amount of shielding placed around them. One bundle is covered with a lead shell which keeps out all protons with energies less than 75-million e.v. and all electrons with energies less than 13-million e.v. The other bundle has a lead shield only around the half projecting into the equipment box. Protons of greater than 10-million e.v. and electrons with energies greater than 0.5-million e.v. can enter the bundle from the unshielded upper half. Particles coming directly from the sun can penetrate the bundles and be counted without having to go through any portion of the spacecraft.

The energy range of particles detected by the half-shielded bundle is similar to the energy range of particles which will be detected by the quartz-fiber ionization chamber. Comparing data from these two instruments will make it possible to determine the average ionization per particle. This in turn will permit determining the type and energy of particles responsible for the measurement—protons, alpha particles, or perhaps heavier nuclei or X rays. It is anticipated that almost all of the particles will be protons.

The total weight of this experiment—counters, lead shielding, and the electronic circuits associated with the counters—is 9 lb, and the experiment draws 0.5 w. J. Denton Allen and Marcia Neugebauer provided JPL's engineering and scientific support for this experiment.

MAGNETIC FIELD ANALYSIS

Ranger carries a rubidium-vapor magnetometer to measure the strength and direction of the magnetic field in interplanetary space. The nature of the interplanetary field is closely related, of course, to the behavior of charged particles in the solar plasma. Data from magnetometer measurements will be of fundamental importance in interpreting Ranger charged-particle experiments, and will provide a new background for evaluating theories of earth-sun relationships

The rubidium-vapor cell resides at the center of a hollow 13-in.-diam. fiberglass spherical shell. Wrapped around this shell are coils of wire through which electric currents of known strengths can be sent during the measuring sequence. By the proper sequencing of currents in the coils, both the strength and the direction of the magnetic field in space can be determined. This unit rides near the front end of Ranger I, as far as possible from the electronic circuitry in and near the hexagonal base, to minimize magnetic background from the spacecraft.

The 5.75-lb, 4.1-w. magnetometer was developed under the direction of J. P. Heppner and J. D. Stolarik of NASA-Goddard SFC. D. E. Jones and M. Gumpel of JPL provided scientific and engineering support for the experiment.

Ranger I and 2 Scientific Experiments Plan

EXPERIMENT	INSTRUMENT	SPONSORING AGENCY	
Solar Plasma	Solar Corpuscular Detector	JPL	Neugebauer/ Snyder
Solar Plasma/ Cosmic Radiation	Semiconductor Detectors and Thin-Walled Geiger Counters a. CdS Photoconductor (SUI) b. Thin-Walled Geiger (SUI) c. Medium-Walled Geiger (SUI) d. Au-Si Counter (U of Chicago)	SUI/U of Chicago	Van Allen/ Simpson
Cosmic Radiation	Ionization Chamber	CIT	Neher
Cosmic Radiation	Triple-Coincidence Telescopes	U of Chicago	Simpson
Magnetic Field	Rubidium Vapor Magnetometer	GSFC	Heppner
Neutral Hydrogen Cloud	Lyman Alpha Telescope	NRL/JPL	Friedman
Cosmic Dust	Micrometeorite Composite Detectors	GSFC	Alexander

SOLAR X-RAY DETECTION

A pair of scintillation counters, part of the AEC's contribution to the Air Force's Vela Hotel project, represent an experiment supplied by John A. Northrop of LASL in cooperation with Sandia. These scintillation detectors are located about a foot apart with sensitive surfaces facing the sun. They are designed to detect bursts of low-energy X rays originating at the sun. Six opaque windows in front of each scintillation detector provide protection against cosmic-dust puncture while permitting the passage of X rays to the detecting portions of the instruments. This equipment will detect extremely short-term variations, so that future instruments can distinguish between man-made nuclear events and solar bursts.

The equipment weighs approximately 12 lb and includes its own power supply, logic, and data-handling system. Timers keep the high voltage removed from the photomulitipliers in the scintillation counters for 8 hr during passage though the earth's radiation belts.

NEUTRAL-HYDROGEN GEOCORONA

This design is under the direction of T. A. Chubb and R. W. Kreplin of NRL, and H. P. Bull and B. D. LaPorte of JPL. It employs a Lyman-alpha telescope and detector to scan the earth as Ranger 1 proceeds far into space. As the telescope mechanically scans this region, the detector produces an electrical signal proportional to the amount of Lyman-alpha light which strikes it, giving a crude TV-like picture.

No one knows exactly what the Lyman-alpha telescope will see. There are theories, however, which could account for a hydrogen cloud extending far into nearby space. Hydrogen is formed by the action of sunlight upon water vapor and methane at an altitude of approximately 60 mi. The released hydrogen gas then diffuses outward to form the main constituent of the earth's very high upper atmosphere. In this high-altitude region, the neutral hydrogen could reflect the Lyman-alpha radiation put out by the sun or could possibly emit radiation of its own after being bombarded by high-energy radiation from the sun or the earth's radiation belts. This would produce a glowing corona around the earth analogous to the sun's.

If the solar wind sweeps out from the sun, as indicated by the shape of comet tails, then the gas at the outer edge of the cloud is probably being continually swept away from the earth, giving the earth a tail like a comet. If no solar wind exists, on the other hand, the neutral hydrogen may simply merge with the more diffuse gas of interplanetary space.

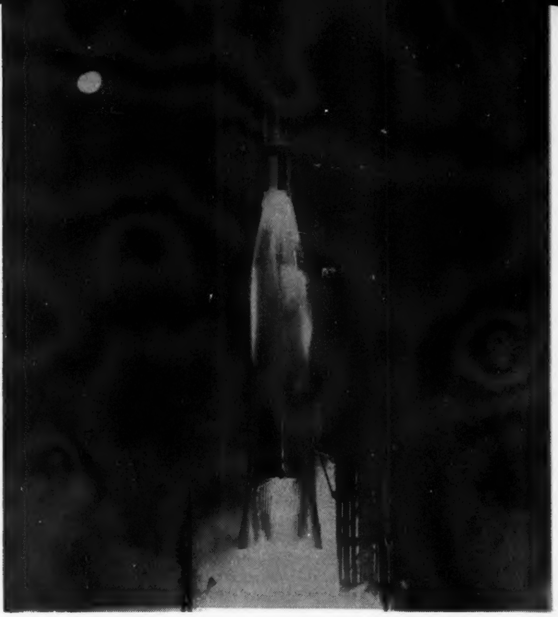
Since the density and behavior of this hydrogen cloud depend on the behavior of the solar plasma and the strength of solar winds, proper interpretation of the data from the Lyman-alpha telescope will require the data from the solar corpuscular radiation measurement as well as the medium energy particle measurements and the magnetometer measurements. The Lyman-alpha telescope may give observations of other phenomena, such as the aurora borealis, and stars which shine with particular brilliance in this special region of the spectrum.

The gimbal-mounted telescope together with its Lyman-alpha detector and the associated electronics weigh 15 lb and draw 1.4 w.

COSMIC DUST DETECTORS

Impact rate, energy, momentum, and direction of flight of dust particles in interplanetary space are measured by a miniature cosmic-dust detector designed at NASA's Goddard SFC under the direction of W. M. Alexander. Housed in a magnesium container measuring 3 by 6 by $5^1/_2$ in., the instrument consists of a flash detector sensitive to minute bursts of light produced by dust-particle impacts and of a special microphone attached to the sensitive exposed surface. The dust experiment is positioned so that it will detect particles moving around the sun in the same direction as the earth and those moving in the opposite (retrograde) direction. Data on the orbits of these particles and on their sizes will give a better understanding of the distribution of matter in the solar system, and provide a much better basis for further calculations on the origin and history of the solar system and material within it.

The cosmic-dust detector and associated electronics weigh 3.55 lb and draw 0.20 w. Marcia Neugebauer and E. S. McMillan of JPL provide scientific and engineering support for this experiment. ◆◆



Ranger 1 on liftoff, at 6:04 a.m. (E.D.T.) Aug. 23. Apogee, 312 st. mi; perigee, 105 st. mi; inclination to equator, 33 deg; period, 91 min.

Preparing Ranger for operations

Efficient space-vehicle design, smooth and timely program coordination, adequate backup testing, and complete systems qualification demand and get scrupulous attention to detail

By Friedrich Duerr

NASA MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.

Friedrich Duerr is manager of the NASA Agena-B Launch Vehicle System at Marshall Space Flight Center. After receiving an M.S. in electrical engineering from the Institute of Technology at Munich, he was with the Siemens Co. until he joined the German Rocket Center at Peenemuende in 1941, where he designed the electrical checkout and firing equipment for both the A-4 (V-2) and A-7 missiles. In 1945, he came to this country under "Operation Paperclip," and was in charge of electrical ground equipment for V-2 and other rocket launches at White Sands. On transferring to Huntsville, Duerr directed design of electrical ground equipment for the Redstone missile, the Jupiter C for reentry and satellite (Explorer) missions, and tactical configurations of Jupiter and Pershing. The ABMA transfer to NASA saw him appointed deputy director for Agena in the Agena and Centaur systems office at MSFC.

In January 1960, a NASA evaluation team studied the feasibility of using the Agena-B vehicle with an Atlas or Thor booster for lunar or satellite missions. A favorable report by that team resulted in a decision to use the Atlas Agena-B as launch vehicle for Ranger lunar missions.

Concurrent with the beginning of contract negotiations with Lockheed Missiles and Space Co. through the AF Space Systems Div. (AFSSD), an organization was established to define and solve interface and operational problems. This organization consisted of JPL, in charge of the Ranger spacecraft development, Marshall Space Flight Center, responsible for the launch vehicle, and Lockheed Missiles and Space Co. as vehicle system contractor. To standardize Air Force and NASA Agena-B vehicle configurations and to manage participating Air Force contractors at the launch facility, AFSSD was to provide operational, technical and administrative support.

These agencies operated through the Agena-B Coordination Board, with the Agena-B Lunar Committee having the responsibility for resolving all technical problems arising in the execution of the missions within its area. To provide the diversified technical skills necessary to fulfill that responsibility, five technical panels were constituted: (1) Vehicle Integration, (2) Performance Control, Trajectories, Guidance and Control Flight Dynamics, (3) Tracking and Data Acquisition, (4) Quality Control and Checkout Procedures, and (5) Firing Operations, Logistics, Facilities and Ground-Support Equipment. These panels function on problems affecting more than one agency involved in the program to determine the existence and nature of problems and assure that steps are taken to provide a solution.

The photo on page 28 shows the object of this planning and coordination—the Ranger vehicle—a modified Atlas-D booster, an Agena-B second stage, and the Ranger spacecraft. The Atlas and Agena are interconnected through an adapter assembly which covers the Agena engine section. This adapter stays with the Atlas when, after booster cutoff, the Agena separates from the adapter section. The Agena and the Ranger spacecraft interconnect through an adapter assembly, and separate at the conclusion of Agena second burn.

Because of the success of the AF Agena program, it was determined at the inception of the program that Atlas and Agena would be held to proved flight configurations, with modifications required for Ranger being as few as possible, and that the guidance and control equipment would be flight-proved and reliable. Reliability of single components as well as operation of the entire system is a point of major design policy with respect to standardization of other NASA missions.

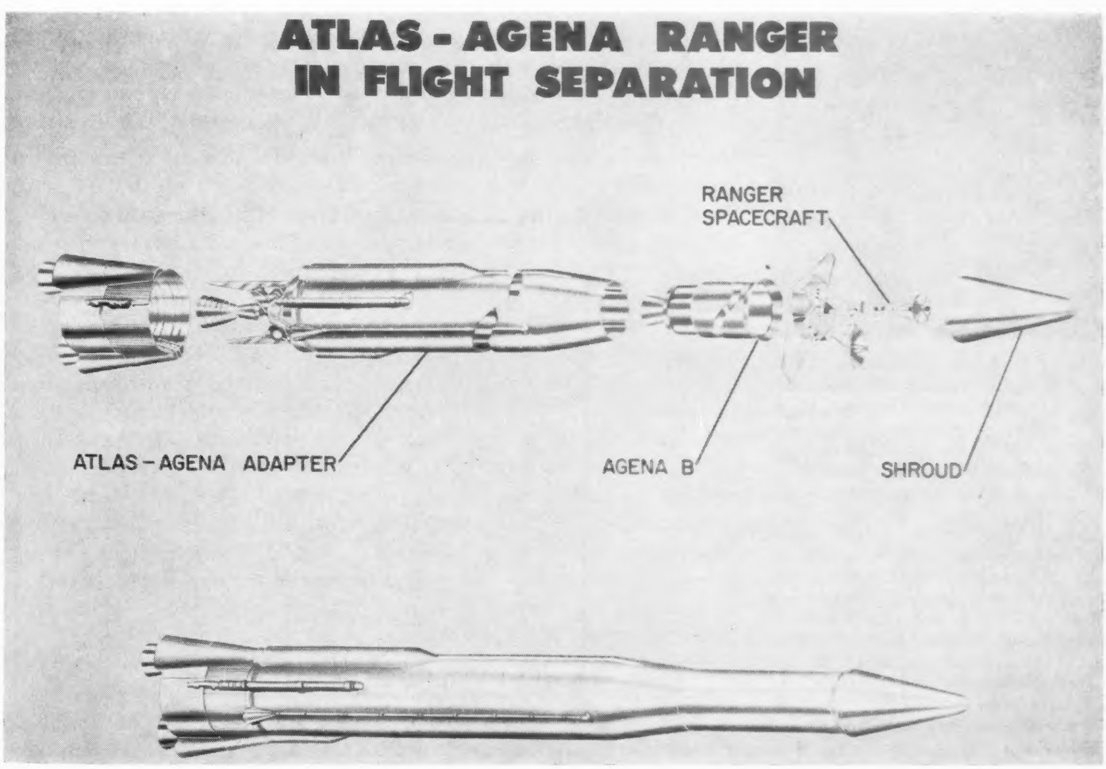
In addition to special Ranger modifications, such as the Agena forward equipment rack, new components had to be designed—for example, an adapter assembly to mate Agena with Ranger proper. A new spacecraft shroud was designed, emphasizing light weight, pressurization capability, and RF requirements. The final design was a one-piece metal shroud with parasitic antennas. This shroud ejects forward, along the line of flight. When possible, designs were laid out in such a way that they could be used in later flights or in other NASA Agena missions.

Parallel with the design effort, analytical studies were made on shroud separation and spacecraft ejection to insure non-interference. Studies were also made to determine the effect of ejection on spacecraft attitude for trajectory optimization, optimum times of engine (both Atlas and Agena) burn, and parking-orbit altitudes for maximum payload capability.

Seek Performance Improvements

Continuous efforts are being made to find new areas in design and operation where performance improvements can be made. All these studies have one common goal—to reduce the weight of booster and spacecraft-support equipment and thus to place the greatest payload at a specified point in space.

Closely related to the analytical studies being conducted in the mechanics and operation of ejection and separation devices was the work of a group assigned solely to insure safe (CONTINUED ON PAGE 54)



The Ranger booster

Atlas D-Agena B vehicle, proven out in other programs, provides the thrust, guidance and control needed for five Ranger lunar missions

By Harold T. Luskin

LOCKHEED MISSILES AND SPACE CO., SUNNYVALE, CALIF.

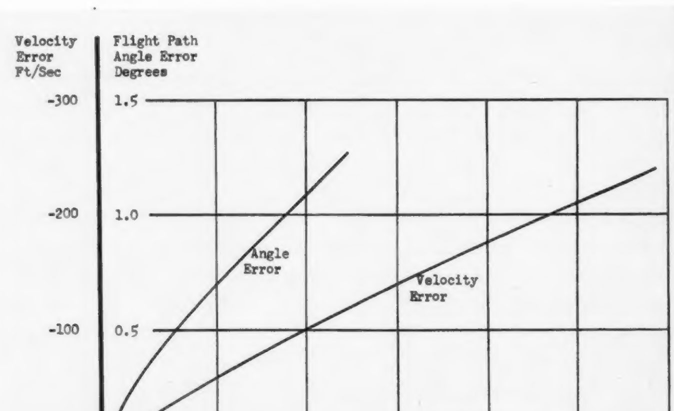
THE BOOSTER for the NASA-JPL Ranger program consists of an Atlas D and an Agena B developed by General Dynamics/Astronautics and Lockheed Missiles and Space Co., respectively. The complete vehicle, at liftoff, is shown in the photograph on page 28. This booster combination was selected for the Ranger Program because the Atlas D, Agena B, and their predecessors have achieved a high maturity of development and reliability through many flights. Agena A and B have been placed in orbit 21 times out of 31 launches as of July 2, 1961. The Agena B is, of course, used on other programs, such as Discoverer, Midas, Advent, Snapshot, Nimbus, S-27, Comsat, and Vela Hotel.

Lockheed Missiles and Space Co. is the launch vehicle systems contractor for the Ranger Program, the contract having been issued by the AF Space Systems Div. for NASA, whose Marshall Space Flight Center is the vehicle manager. The Ranger Program is part of the NASA plan (Surveyor, Prospector, Apollo, etc.) to place man on the Moon and return. The Ranger payload, developed by JPL, carries equipment to determine characteristics of the Moon's surface and environment, and is described in detail elsewhere in this issue.

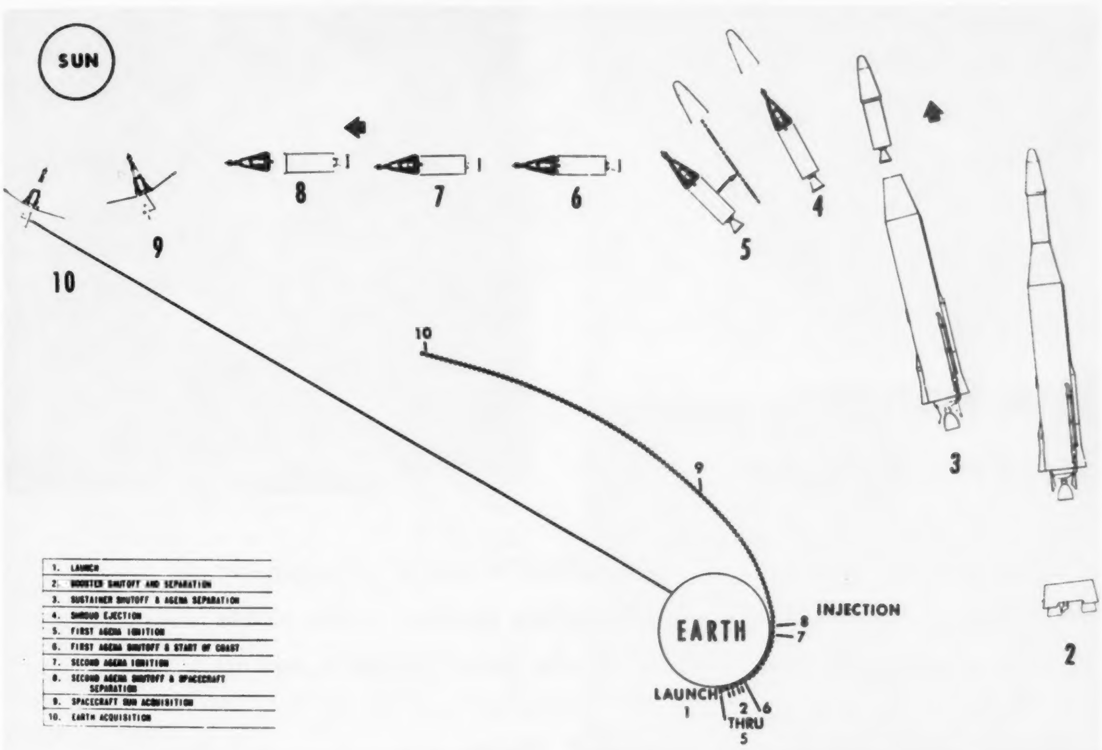
Five Ranger flights are included in the contract. Orbits desired

Harold T. Luskin is manager of the NASA/Agena Program, which includes the Ranger, Nimbus, Comsat, and S-27 vehicles, at Lockheed. A graduate of the Univ. of Michigan, his industrial experience has included direction of aerodynamic research, design and testing of the DC-8, Nike-Zeus, Honest-John, Nike-Ajax, XB-43 and other projects. He is also a co-designer of the AF-NACA X-3 supersonic research aircraft. Currently a member of the Advisory Panel on Aeronautics to the Assistant Secretary of Defense for Research and Engineering, he is an IAS Fellow and Western regional vice-president of IAS, and a member of ARS, AAS and BIS.

Permissible Injection Error (Circular Orbit)



Ranger A Launch-To-Injection Sequence



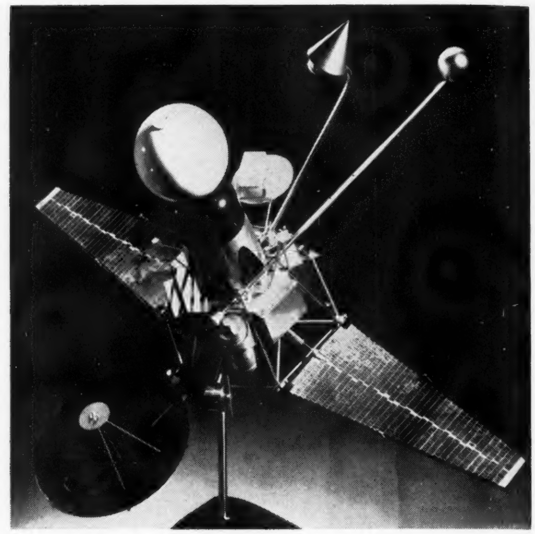
for the first two flights are highly eccentric, with an apogee equal to about $2^1/_2$ times the Earth-Moon distance. The first flight gave only a near-Earth orbit, but nevertheless a flight test of the complete system was achieved. The last three flights will place the instrumented capsule on the Moon.

Since the trajectory that provides Moon impact is the more interesting, it will be described here. The trajectory, sequence of events, and relationship of the Earth and Sun is shown in the drawing above. In general, the Atlas boosts the Agena and payload to an apogee of 100 n.mi.; the first burn of the Agena occurs to place it and the payload in a circular parking orbit of 100 n.mi.; the second burn then begins and goes on until injection into the lunar trajectory, when at burnout the payload is separated. The payload contains propulsion for a mid-course maneuver and to slow the capsule to a safe velocity for lunar impact. Use of the Agena in two burns rather than one allows a heavier payload to be carried because the Atlantic Missile Range (AMR) is not in the most ideal geographic location for the most efficient trajectory to the Moon when using a single Agena burn rather than the dual. With the dual-burn trajectory, the angle from the Agena at the end of first burn to the center of the Earth to the Agena at the beginning of second burn is about 50 deg, and this distance is travelled without any use of propulsion.

A more detailed description of the trajectory sequence of events and the vehicle system follows:

The time of launch has a window which is actually the amount of time in which a launch must be made. Time of launch is determined by the phase of the Moon (it must be illuminated so that impact can be observed, the Earth-Moon plane being such that a launch from AMR can be made in that plane and impact the Moon), the satisfaction of range safety restraints, etc. The duration of the window is then determined by analysis of tolerances of all the restraints that establish the time of launch. For example, the launch azimuth can usually be within about a 12-deg band and satisfy range safety requirements. The time of launch that allows maximum payload capability and satisfies all restraints occurs once each day for four days each month. The launch window varies from nearly two hours on the first allowable day of launch to about one hour on the last day.

At Ranger liftoff, the two booster and one sustainer engines of the Atlas are operating and guidance is performed by a (CONTINUED ON PAGE 73)



The Ranger lunar capsule

What looks like a beach toy will deliver a sterile seismometer and related equipment to the moon's surface to open a new phase in lunar exploration and probing of the solar system's secrets

Frank G. Denison is Aeronutronic's Manager of Lunar Capsule, Space Systems Operations, the group responsible for the Ranger rough-landing capsule under Aeronutronic's subcontract to JPL. Denison has 20 years' engineering and management experience in aeronautical, marine, jet propulsion and aerospace fields, and holds a B.S. in naval architecture and marine engineering from MIT and an M.S. in aeronautical engineering and an A.E. in aeronautics from CalTech. At one time on JPL's staff, he was program director for the Sergeant missile system; participated in the management of the Corporal missile system and was personally responsible for the conception, analysis, and design for the Corporal rocket motor; and was chief of JPL's Design and Development Section, where he supervised the design, construction, and flight testing of the Wac Corporal, Bumper Wac, and two test vehicles.

By Frank G. Denison

AERONUTRONIC, DIV. OF FORD MOTOR CO., NEWPORT BEACH, CALIF.

An important part of the Ranger mission is the depositing of sensitive working instrumentation upon the surface of the Moon and transmitting back to Earth the results of the scientific and engineering data obtained therefrom. Such data will be of substantial value in the implementation of the more sophisticated programs required to achieve the major objectives of the national space program. These early lunar landings in themselves are an important part of our exploration of space, because they can immediately yield information concerning the Moon's formation and structure and provide some knowledge of the environment in which man will explore the Moon further.

The lunar capsule is a Ranger spacecraft subsystem developed by Aeronutronic, a Div. of Ford Motor Co., under a subcontract from the Jet Propulsion Laboratory. The capsule is carried to the immediate vicinity of the Moon by the Ranger "bus." The distance to the Moon is then automatically measured; and, when a predetermined altitude above the lunar surface is reached, the capsule separates from the bus and brakes itself by means of a retrorocket to allow a survivable landing.

When the capsule comes to rest on the surface of the Moon, the survival sphere floated within the capsule's impact limiter will automatically erect itself to local vertical by means of Moon gravity, just as a spherical compass stays vertical. This places vertical the sensitive axis of the primary scientific instrument—a seismometer—and permits the use of a modestly directional transmitting antenna.

Telemetry will relay scientific and engineering data back to the Deep Space Instrumentation Facility, described on page 34, for an extensive period of time after each landing. The seismometer will not only provide a record of "moonquakes" and meteoric impacts, should they occur, but will also record the continuous, microscopic seismic motions that are believed to exist on the Moon just as they do on Earth. From such data much can be deduced about the structure of the Moon, information which will lead to filling some of the gaps in our knowledge about the origin and history of the solar system.

As can be seen in the photograph on the opposite page, the lunar capsule outwardly resembles an oversize beach ball set on a retrorocket. In addition, there are certain exterior components attached directly to the capsule or to the Ranger bus. One of the exterior components, the altimeter which rides on the bus structure, senses the proper instant during the approach to the Moon for separating the capsule system from the transporting vehicle. In the nozzle of the retrorocket are auxiliary spin rockets which provide spin stabilization for the braking part of the trajectory. The landing sphere is capped by the bus telemetry antenna, which is moved out of the way before separation.

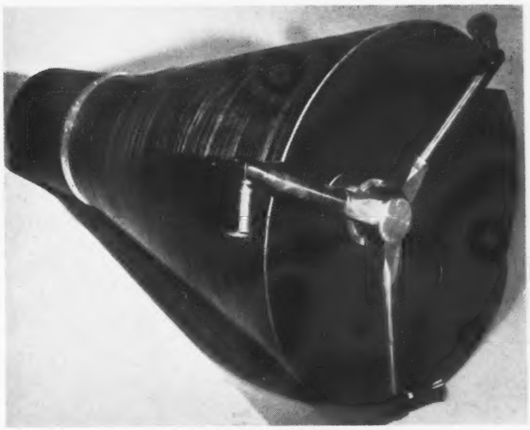
The landing sphere consists of a crushable, spherical impact limiter, which will absorb residual velocities at landing. Centered in this is the instrument-packed survival sphere, which forms the true mission payload. The survival package, which is fluid-floated within the hollow impact limiter, contains the seismometer, temperature-control system, transmitter, power supply, and other components, such as timing and control devices. The table on page 78 lists the elements of the lunar capsule and their weight.

Altimeter Operation

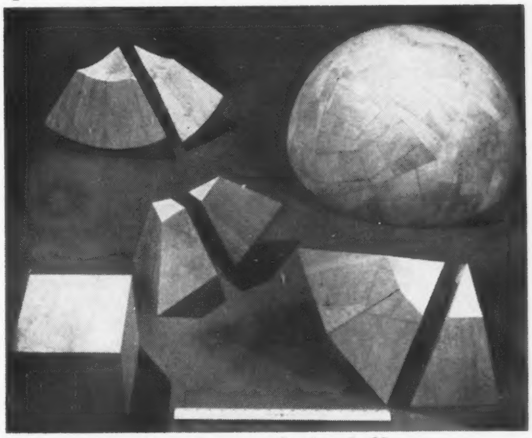
The altimeter, being developed for Aeronutronic by Wiley Electronics Co., is basically a fuze-type radar for measuring the distance of the Ranger spacecraft from the Moon. At a precise altitude yet to be selected (about 70,000 ft), it will signal for bus–capsule separation.

In addition, the altimeter will also provide to the bus telemetry a signal proportional to the received echo strength. This will yield both scientific data aiding in the description of the lunar surface and engineering data on its surface reflectivity, which will allow better use of altimetry and doppler devices in future lunar hard and soft landings.

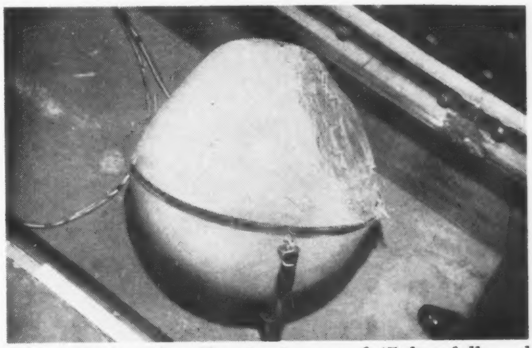
When the altimeter determines that the combined Ranger spacecraft (CONTINUED ON PAGE 77)



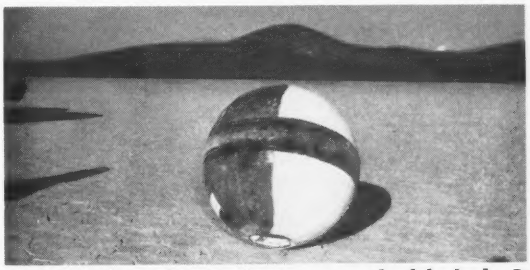
Spin motor in retrorocket nozzle.



Balsa construction of impact-limiter half.



Impact limiter after glancing impact of 45 deg, followed immediately by a 90-deg impact to bring it to rest.



Landing sphere after coming to rest on dry-lake bed. It was dropped from an aircraft at an altitude that would simulate lunar drop.

DSIF in the Ranger project

This worldwide network—with permanent stations in California, South Africa and Australia—will track, telemeter, and command Ranger, and will add capabilities itself as the project advances

By N. A. Renzetti

NASA JET PROPULSION LABORATORY, PASADENA, CALIF.

Nicholas A. Renzetti heads Communications Engineering and Operations for JPL's Telecommunications Div. His background includes a Ph.D. in physics from Columbia Univ. in 1940, various technical and administrative positions with the Navy between 1941 and 1954—technical director of the 12th Naval District's Underwater Ordnance Mine and Countermine Warfare, head of the China Lake Naval Ordnance Test Station's Measurements Div. and Test Dept., and head of the NOTS-Pasadena Underwater Ordnance Dept.—and chief physicist for the Air Pollution Foundation, San Marino, Calif., from 1954 to 1959, when he joined JPL. Dr. Renzetti is also a consultant to NOTS-Pasadena and Stanford Research Institute.

As a scientific experiment, the Ranger Project requires ground-support equipment capable of providing near-optimum communication and tracking capabilities. Both the received radio-signal frequency and spacecraft angle-tracking data are required for the measurement of spacecraft velocity and position, and radio communication is required for the transmission of telemetering data and of commands. The accuracy and precision of the tracking and communications equipment determine to a large extent the validity of the experimental data obtained.

The NASA Deep Space Instrumentation Facility (DSIF) is a scientific instrument specifically designed and continually updated to provide state-of-the-art tracking and communications capabilities for space probes. As such, it is a basic part of the instrumentation and control system of the Ranger experiment. The DSIF can maintain continuous communication with the space vehicle, using three stations located at approximately equal intervals around the world. Permanent Deep Space Stations (DSS) are located at Goldstone, Calif.; Woomera, Australia; and near Johannesburg, South Africa. In addition, a Mobile Tracking Station is located near the Johannesburg Tracking Station close to the injection point of the spacecraft for the Ranger Project. The chart on page 35 shows the visibility horizon of each DSS for different space-vehicle altitudes.

Each of the Deep Space Stations of the DSIF is operated by personnel provided by cooperating agencies of the respective country. The Woomera Tracking Station is operated by personnel of the Australian Department of Supply, and the Johannesburg Tracking Station is operated by personnel of the National Institute for Telecommunications Research of the South African Council for Scientific and Industrial Research. The Goldstone Tracking Station and the Mobile Tracking Station are operationally supported by Bendix Corp. under JPL contract. JPL is responsible to NASA for the development and fabrication of the stations and for the technical coordination and liaison necessary to perform each tracking and communications mission.

Each permanent DSIF station consists of an 85-ft-diam polar-mount antenna, an electrohydraulic servosystem, an extremely sensitive tracking receiver, and data-handling and telemetering equipment. A block diagram of a typical DSS appears on page 36 The overseas stations at Woomera, Australia, and Johannesburg, South Africa, are similar to this basic configuration. The Goldstone

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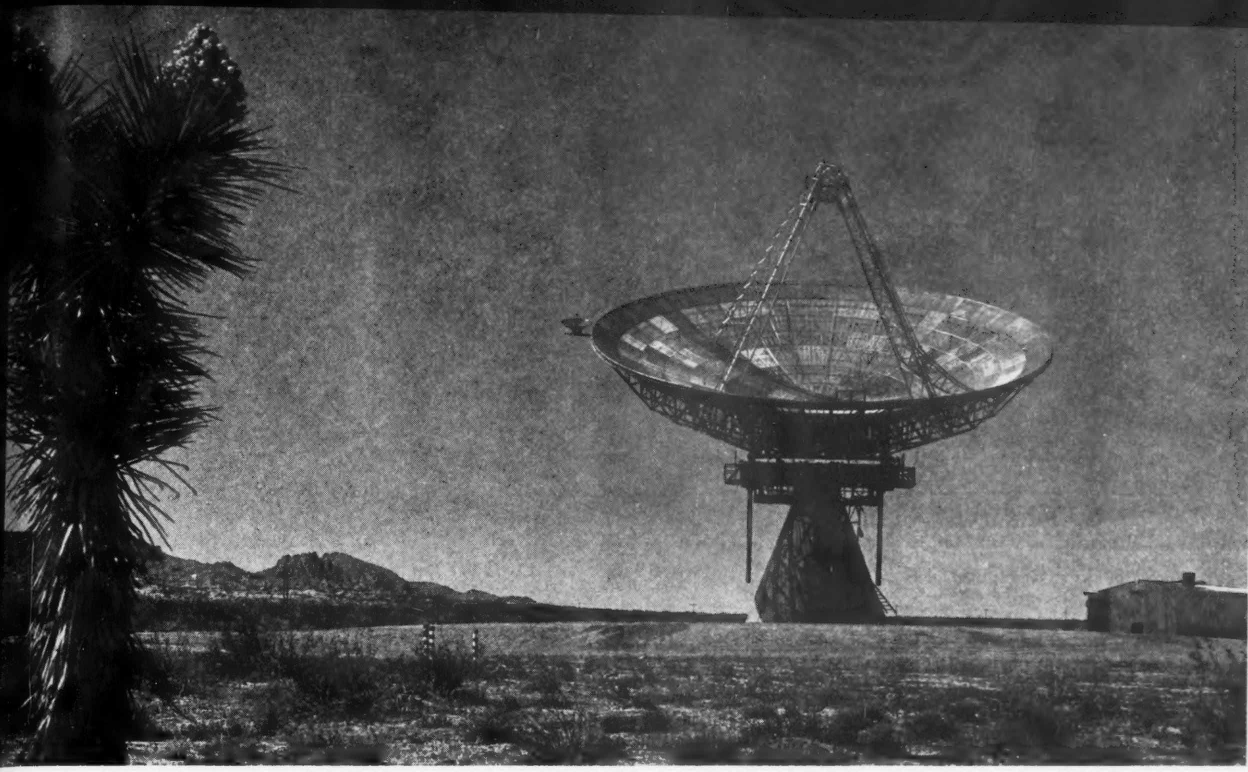
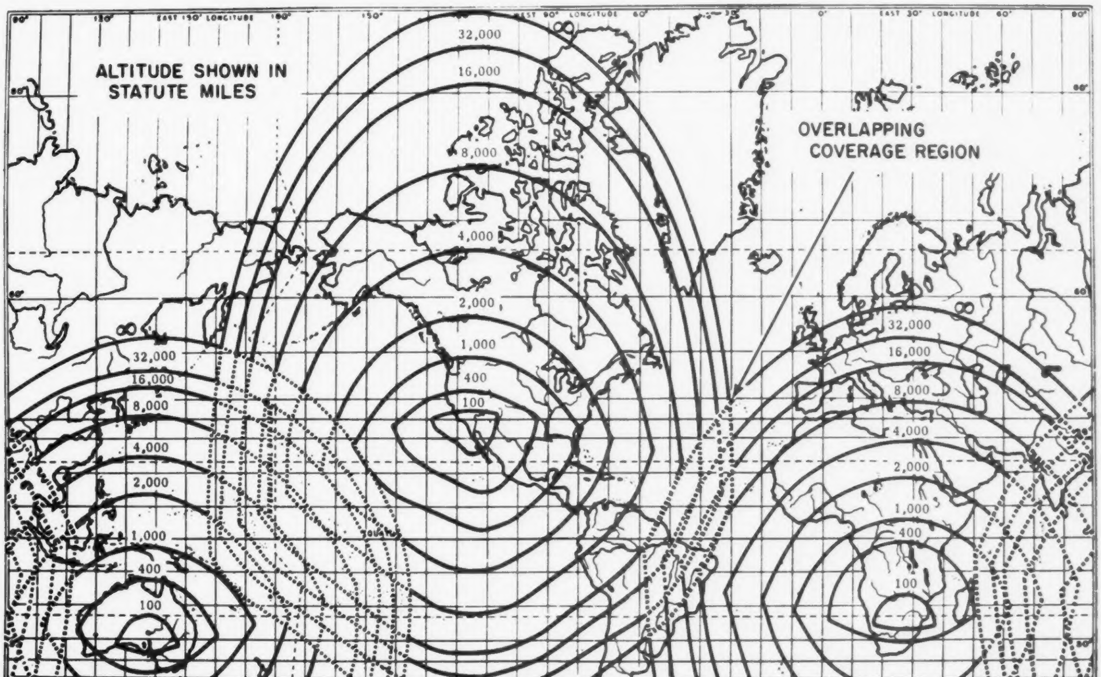
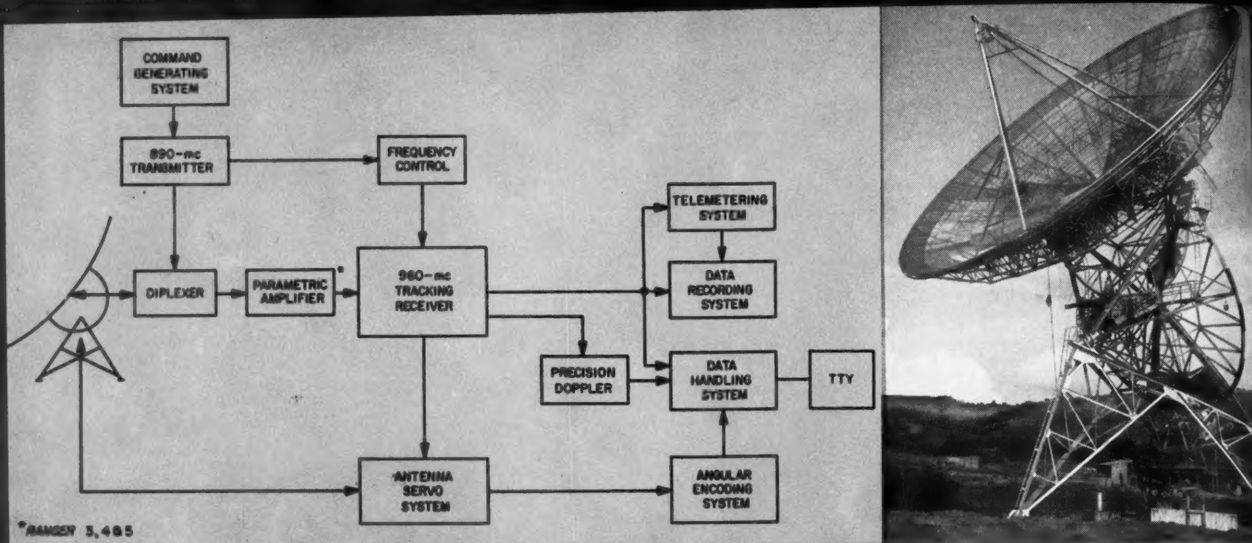


The 85-ft Altazimuth Antenna of Goldstone DDS

DSIF Loci of Sub-Vehicle Points for Horizon Visibility





Left, block diagram of typical DSIF Station and, right, the 85-ft Polar-Mount Antenna of Johannesburg

Station has, in addition to an 81-ft-polar-mount (HA-Dec) antenna, an 85-ft altazimuth (Az-El) antenna, shown in the photos above and on page 35. For command and two-way doppler purposes, this Az-El antenna installation incorporates a 200-watt diplexed transmitter in addition to the standard receiver system. The Goldstone Station, besides being used for tracking operations, is also used for communications-system research and development and for the development of new DSIF equipment. New or improved equipment is tested at Goldstone before being installed at the overseas stations.

Keeps Antenna Pointed at Probe

The primary tracking function of the DSIF is to keep the antenna pointed toward the space probe, so that continuous RF communications can be maintained. Acquisition of the target is accomplished either by pointing the antenna according to the precalculated ephemeris or, if desired, by using a search pattern. Two search patterns are available at hour-angle-declination antenna installations: a spiral scan, which causes the antenna to spiral outward from some initial preset angle coordinates, or a sawtooth scan, which causes the antenna to sweep back and forth across a rectangular area. The spiral scan will not be used at these stations for the Ranger mission, and the sawtooth scan will be used only for acquisition when the probe comes over the horizon.

Once the probe has been "acquired," the antenna tracks it automatically using a phase-locked simultaneously lobing system. The angle of the antenna with respect to the signal source is determined by adding and subtracting the signals received by each of the four overlapping lobes of the antenna pattern. The sum and difference signals are then compared in both amplitude and phase and the resulting signals are introduced into the three-channel tracking receiver.

The DSIF stations incorporate a highly stable narrow-band double-conversion receiver which can be phase-locked to the spacecraft transmitter frequency. The receiver provides the information necessary for precise measurement of signal frequencies, for angular tracking of the signal source, and for detection of the phase-modulated telemetered data. The receiver contains three channels: a reference channel and two angle-error channels. The reference signal is used to obtain doppler, telemetry, and signal characteristics for recording and contains the phase-lock loops for frequency mixing and the phase reference and AGC control for all three channels. The two angle-error channels produce signals which are proportional to the error of the antenna-pointing angle. These error signals are fed to the servo-control system and position the antenna for automatic tracking of a received signal. A semiautomatic acquisition-control assembly is incorporated in the receiver to facilitate synchronization of the receiver frequency to that of the space-vehicle transmitter.

Since all three of the DSIF stations are utilized on a space-probe mission, a teletype communications net has been established between the stations and JPL. The communications net is required for the coordination of effort required for the conduct of each mission and provides a means for transmitting technical data; the teletype net is also used to transmit tracking, scientific, and engineering data to a Central Computing Facility. This facility is located at JPL and computes the ephemerides and prediction data and mid-course maneuver requirements for the spacecraft, and processes scientific and engineering data from the stations.

The nominal durations for the Ranger 1 and 2

missions are 150 days, and for the majority of the time the DSIF will provide 16 to 20 hr of tracking coverage per day, using two stations each day. Each of the three permanent DSIF stations will operate on a one-day-off, two-day-on schedule. The DSIF will provide tracking information and raw telemetry information; and, in addition, the Goldstone Tracking Station will have the capability of transmitting commands to the spacecraft when required.

The DSIF data records will be shipped to JPL for analysis and reduction. The more important of these records will be the teletype tape and the page-printer copy of the tracking data and the magnetic-tape record of the telemetry data. The critical nature of certain data during portions of the mission, however, will require real-time or near-real-time teletype transmission of some data. These data, which are to be transmitted to the Central Computing Facility, will be processed in real time or near-real time for teletype transmission, and will be labelled with identification parameters.

During the first three days of these missions, when the DSIF is providing 24-hour coverage, the tracking data and selected engineering telemetry measurements will be transmitted in real time or near-real time. After the first three days, when the DSIF coverage has been reduced and the spacecraft orbit and operation have been evaluated, the scientific telemetry data will have priority and will be transmitted in real time. The tracking data, consisting of time-labelled antenna-pointing angles and a doppler-frequency measure, are recorded in a format suitable for teletype transmission. The telemetry data will be transmitted via teletype by using, in the case of the scientific data, an encoder which records the data in a format suitable for teletype transmission and, in the case of the engineering data, by transcribing into a teletype format selected data from the digital printout of the engineering telemetry decommutator.

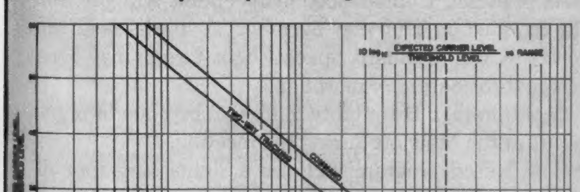
The doppler-tracking data provided by the DSIF will be of two general types: a one-way doppler measurement, in which the signal from the spacecraft is derived from the oscillator in the spacecraft, and a two-way measurement, in which the spacecraft signal is a coherent multiplication of the transmission from a ground station. For the Ranger 1 and 2 missions, the only station with two-way doppler capability is the Goldstone Station. At Woomera and Johannesburg only one-way doppler data are available.

Employs Two Frequencies

The DSIF–spacecraft two-way communications system installed at Goldstone employs two separate frequencies: one for transmission to the spacecraft and one for reception from the spacecraft. The use of two frequencies is necessary because two-way doppler cannot be obtained using a single frequency. The actual selection of the frequencies, however, is governed by diplexer and antenna considerations. If the frequencies differ by less than 6%, the diplexer cannot separate the transmitted and received frequencies; and if they differ by more than 10%, the use of a single antenna for both frequencies is difficult. The DSIF transmits 890 mc to the space vehicle. The spacecraft transponder receives this signal, multiplies it by 96/89, and retransmits 960 mc back to Earth.

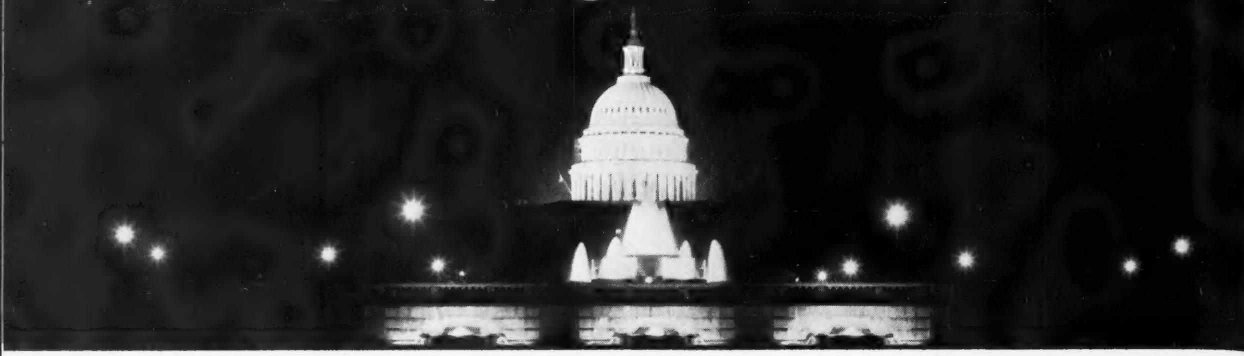
The primary advantage of a two-way system is the increase in the accuracy of frequency measurements for doppler detection. The DSIF doppler-detection system references the measured frequency of the received signal to the transmitted frequency in the case of two-way (CONTINUED ON PAGE 70)

Typical spacecraft-to-Earth communications capability for Ranger 1 and 2.



Typical Earth-to-spacecraft communications capability for Ranger 1 and 2.

IAF Congress program announced



16 Technical Sessions planned . . . Academy of Astronautics, Institute of Space Law to meet . . . Social events, special ladies' program set

THE PROGRAM for the XIIth International Astronautical Congress, to be held the week of Oct. 2–7 at the Marriott Twin Bridges Motor Hotel in Washington, D.C., was announced last month by Samuel Herrick, chairman of the Congress Committee. The American Rocket Society will act as host society, in cooperation with the two other American members of the International Astronautical Federation—the American Astronautical Society and the Aero-Space Medical Assn.—for the meeting, the first IAF Congress to be held in the U.S.

All of the Technical Sessions, the meetings of the International Academy of Astronautics and Institute of Space Law, and the banquet will be held at the Marriott. Receptions and other social events will be held at various sites in downtown Washington.

The meeting is expected to draw an attendance of more than 750 delegates from some 30 IAF member societies from all parts of the world. Leonid I. Sedov of the USSR Academy of Sciences is president of the IAF.

The 16 Technical Sessions will bring together more than 100 authors and panelists, who will cover such topics as astrodynamics and guidance, space propulsion, energy conversion, space physics, combustion, bioastronautics, space communications, vehicles, and structures. In addition, morning and afternoon sessions on Friday, Oct. 6, will be reserved for general papers which do not fall into any of these categories. Technical sessions will be held on Tuesday, Wednesday, and Friday.

The Congress will be officially opened at a special ceremony to be held at 5 p.m. on Monday afternoon, Oct. 2, in the auditorium of the Smithsonian Institution Natural History Museum. Plenary sessions will be held Monday morning and afternoon and Friday morning at the Georgetown Univ. Institute of Languages and Linguistics, where special IBM equipment will be available for immediate translation of the proceedings. The International Academy of Astronautics will meet Tuesday morning, while the International Institute of Space Law has scheduled morning and afternoon sessions Tuesday and Wednesday. The Ad Hoc Life Sciences Committee will meet Monday afternoon. A full schedule of IAF Committee meetings will be announced prior to the Congress.

In addition to the technical program, a social program and a special ladies' program have been arranged. An ARS National Capital Section meeting for registrants will be held Sunday evening, while AFOSR and NASA will host receptions on Monday and Tuesday evening. A reception at the National Gallery is planned on Wednesday evening, while Thursday will be devoted to the boat trip—this year to Mount Vernon—which has become a tradition at IAF Congresses. An ARS National Capital Section reception will precede the banquet on Thursday evening. A special field trip to the NASA Goddard Space Flight Center has been planned for Saturday morning.

In addition, a Hospitality Suite will be open to registrants at the Marriott during the meeting.

The ladies' program includes a sightseeing tour of the city, a White House tour, a tea at the Washington International Center, and visits to a number of private homes in the city.

Bus transportation will be available to take delegates to and from the various parts of the city where the different events are scheduled.

The complete IAF Congress technical program is as follows:

Tuesday, October 3

SPACE PROPULSION

9:00 a.m. **Persian Ballroom I**

Chairman: Frank E. Rom, Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio.

✦Propulsion of the Final Stage of a Satellite Launcher Using Liquid Hydrogen as Fuel, A. W. T. Mottram, Bristol Siddeley Engines, Ltd., Coventry, Warwickshire, England.
✦Summary of U.S. Nuclear Rocket Program, Harold B. Finger, National Aeronautics and Space Administration, Washington, D.C.
✦Note Sur Les Systemes De Propulsion Spatiale A Source D'Energie Separee et a Vitesse D'Ejection Elevee, P. Blanc, Societe Francaise D'Astronautique, Paris, France.
✦An Examination of the Characteristics of Propulsion Systems for Interorbital Transfer, P. A. E. Stewart, Hawker Siddely Aviation Ltd., Bristol, England.
✦Optimisation de la Propulsion Trans-Satellite, J. Martelly, Paris, France.

ASTRODYNAMICS AND GUIDANCE ROUNDTABLE

9:00 a.m. **Potomac Ballroom**

Chairman: Robert M. L. Baker Jr., Univ. of California, Los Angeles, Calif.

It is tentatively planned to present a roundtable discussion on the Determination of the Astronomical Units by the Americans and Russians and a panel discussion of the Application of Optimization Theory to Astrodynamics.

FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE

International Institute of Space Law

Session I

9:00 a.m. **Persian Ballroom II**

Chairman: Michel S. Smirnoff, Foreign Trade Research, Institute, Belgrade, Yugoslavia.
✦Sharing the Wonders of Space, Victor L. Anfuso, House of Representatives, Washington, D.C.
✦The Morphology of Justice in the Space Age, Fritz Zwicky, California Institute of Technology, Pasadena, Calif.
✦Outer Space—The Key to World Peace Under Law, David F. Maxwell, American Bar Association, Philadelphia, Pa.
✦Metalaw—The Science of Universal Jurisprudence, Andrew G. Haley, Haley, Wollenberg & Bader, Washington, D.C.
✦Some Legal Aspects of Corporate Activites in Space, C. Wilford Jenks, International Labour Office, Geneva, Switzerland.
✦Certain Aspects of the Question of Innocent Passage of Space Vehicles, Jacek Machowski, Permanent Mission to the United Nations, New York, N. Y.
✦The Social Impact of Communications Satellites, Arthur C. Clarke, Clarke-Wilson & Associates, Colombo, Ceylon.

FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE

International Institute of Space Law

Session II

2:30 p.m. **Persian Ballroom II**

Chairman: C. Wilford Jenks, International Labour Office, Geneva, Switzerland.
Vice-Chairman: Franco Fiorio, Consul General, Republic of San Marino, Washington, D. C.

✦Anticipating Remote Contingencies: Encounters with Living Forms, Harold D. Lasswell, Yale Univ. Law School, New Haven, Conn.
✦The Role of International Organization in Developing The Law of Outer Space, Oscar Schachter, General Legal Div., United Nations, New York, N. Y.
✦The Problem of Interpreting Attitudes Toward Space Activities, Donald N. Michael, Peace Research Institute, Washington, D.C.
✦Space Law—Point of View of a Small Country, Franco Fiorio, Consul-General, Republic of San Marino, Washington, D.C.
✦Sovereignty in Outer Space, Welf Heinrich, Prince of Hanover, Frankfurt/Main, Germany.
✦The Legal Problems of Demilitarization and Neutralization of Outer Space, Vladimer Kopal, Czechoslovakian Academy of Sciences, Prague, Czechoslovakia.
✦The Applicability of the Organization of the International Atomic Energy Agency to Space Activities, Eilene Galloway, U.S. Senate, Washington, D. C.
✦The Problem of Applying Terrestrial Law in Outer Space, Hassan Safavi, Ministry of Roads, Teheran, Iran.
✦The Legal Status of the Astronaut, Aldo Armando Cocca, Estudio Juridico de los Dres, Buenos Aires, Argentina.

ENERGY CONVERSION

2:30 p.m. **Persian Ballroom I**

Chairman: Abe M. Zarem, Electro-Optical Systems, Inc., Pasadena, Calif.

✦Development of Nuclear Power in the United States for Space Applications, Lt. Col. Guveren M. Anderson and Cmdr. Donald L. Jarrell, Snap Branch, Atomic Energy Commission, Washington, D.C.
✦Dynamic Flight Vehicle Power Systems, George Sherman, Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio.
✦Fuel Cell Progress, Programs, and Problems, Ernst Cohen, Army Research Office, Washington, D.C.
✦High Drain Fuel Cells Operating at Ambient Temperatures, Eduard W. Justi and August W. Winsel, Technische Hochschule, Braunschweig, Germany.
✦Solar Direct Conversion Power Systems, William C. Cooley and Walter C. Scott, National Aeronautics and Space Administration, Washington, D.C.
✦Space Power Sources by Thermoelectric and Thermionic Emission Processes, Paul H. Egli, U.S. Naval Research Laboratory, Washington, D.C.

ASTRODYNAMICS AND GUIDANCE

2:30 p.m. **Potomac Ballroom**

Chairman: Robert M. L. Baker Jr., Univ. of California, Los Angeles, Calif.

This session will include a mixture of short, invited papers, contributed papers, and roundtable discussions on the following topics:

1 Rendezvous: Orbital and Guidance Problems
2 Orbit Selection, Modification and Guidance Problems
3 Attitude Stabilization
4 Selection of Parameters for Peturbation Integration
5 Orbit Determination
6 Geodesy
7 Stability of Special Orbits
8 Trajectory Integration

Participants:
Dirk Brouwer, Yale Univ., New Haven, Conn.
Zdenek Kopal, Univ. of Manchester, Manchester, England.
George Leitmann, Univ. of California, Berkeley, Calif.
Samuel Herrick, Univ. of California, Los Angeles, Calif.
(Additional participants to be announced)

FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE

International Institute of Space Law

Session III

7:30 p.m. **Persian Ballroom II**

Chairman: Oscar Schachter, General Legal Div., United Nations, New York.
Vice-Chairman: Vladimir Kopal, Czechoslovakian Academy of Sciences, Prague, Czechoslovakia.

✦The Space Age Challenges Behavioral Sciences: Some Problems and Implications, William E. Noland, Institute for Research in Social Sciences, Chapel Hill, N. C.
✦The Legal Nature of Celestial Bodies, Ernst Fasan, Defense Attorney, Neunkirchen, Austria.
✦Legal Problems of Outer Space as a Factor in World Peace and Progressive Science, Todor Gabrovski, Sofia, Bulgaria.
✦Aggressive Uses of Space Vehicles—The Remedies in International Law, Nicholas N. Kittrie, U.S. Senate, Washington, D. C.
✦Space Law as an Element of Understanding Among the Peoples on Earth, Michel S. Smirnov, Foreign Trade Research Institute, Belgrade, Yugoslavia.
✦Astronautics As An Accelerating Force in Social Change, James Stephen Hanrahan, Aeronutronic, Div. Ford Motor Co., Newport Beach, Calif.
✦Jurisdiction Over Land Masses in Space, Martin Menter, Federal Aviation Agency, Washington, D. C.
✦Can Individual Nations Obtain Sovereignty Over Celestial Bodies? Julian G. Verplaetse, Heirenthoek, Landegem, Belgium.

Wednesday, October 4

EXPLORATION OF THE SOLAR SYSTEM BY RADAR AND RADIO ASTRONOMY—SESSION I

Lee, Potomac, and Arlington Rooms
9:00 a.m.

Chairman: Herbert Friedman, U.S. Naval Research Laboratory, Washington, D.C.

The Moon

✦Radar Mapping, G. Pettengill, Massachusetts Institute of Technology, Lincoln Laboratories, Cambridge, Mass., and R. L. Leadabrand, Stanford Research Institute, Stanford, Calif.
✦Lunar Orbit, B. Yaplee, Naval Research Laboratory, Washington, D.C.
✦Pencil Beam Radiometry, David Cudaback, Stanford Univ., Stanford, Calif.
✦Eclipse Radiometry, J. E. Gibson, Naval Research Laboratory, Washington, D.C.
✦Radio Characteristics of Lunar Surface Material, K. M. Siegel, Univ. of Michigan, Ann Arbor, Mich.
✦Mercury, Mars, Saturn Radiometry, F. Haddock, Univ. of Michigan, Ann Arbor, Mich.

Venus

✦Radar, G. Pettengill, Massachusetts Institute of Technology, Lincoln Laboratories, Cambridge, Mass., and E. Rechtin, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.
✦Radiometry, C. Mayer, Naval Research Laboratory, Washington, D.C.

BIOASTRONAUTICS—SESSION I

9:00 a.m. **Persian Ballroom I**

Co-Chairmen: Gustav Schubert, Physiological Institute, University of Vienna, Vienna, Austria.
Rodolfo Margaria, Instituto de Fisiologia Umana, Universita di Milano, Milano, Italy.

✦Regeneration: Chemical or Biological,

Denzel L. Dyer, Space Biotechnology Section, The Martin Co., Baltimore, Md.
✦Bio-Engineering Investigation of Integrated Physico-Chemical Life Support System Concepts, Edward L. Hayes and Roland A. Bosee, Air Crew Equipment Laboratory, Naval Air Materiel Center, Philadelphia, Pa.
✦Life Support System—Slave or Master?, Robert K. Ames, Aerospace Div., The Boeing Co., Seattle, Wash.
✦Influence of Lunar and Zero Gravity Upon Germination and Growth of Plants, W. Taufman, Space, Environment, and Life Sciences, Republic Aviation Corp., Farmingdale, N.Y.
✦Mars as an Object of Exploration and Settlement, Wells A. Webb, Hexcel Products, Inc., Berkeley, Calif.
✦On the Possible Existence of Intelligent Living Beings on Other Planets, Rodolfo Margaria, Instituto de Fisiologia Umana, Universita de Milano, Milano, Italy.
✦Effects of a Steady Magnetic Field on Cerebellar Centers for Equilibrium and Orientation, Torquato Gualtierotti, Laboratorio de Fisiologia Umana, Universita de Milano, Milano, Italy.

TRENDS IN COMBUSTION RESEARCH RESULTING FROM EXPLORATION IN SPACE

9:00 a.m. — Persian Ballroom II

Chairman: Peter L. Nichols, Space Sciences and Propulsion Div., Stanford Research Institute, Menlo Park, Calif.

✦Combustion Instability in Solid Rockets, F. T. McClure, R. W. Hart, and J. F. Bird, Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Md.
✦The Role of Combustion Research in Rocket Propulsion, S. S. Penner, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.
✦Chemical Detonations in the Upper Atmosphere, K. M. Foreman and P. Wilson, Plasma Propulsion Project, Republic Aviation Corp., Farmingdale, N.Y.
✦Atomic Reactions in the Upper Atmospheres of Earth, Mars, and Venus, Charles Barth, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE

International Institute of Space Law

Session IV

9:00 a.m. — South Room

Chairman: John Cobb Cooper, International Law Association, Princeton, N. J.
Vice-Chairman: Antonio Ambrosini

✦Working Group III
Michel S. Smirnov, Foreign Trade Research Institute, Belgrade, Yugoslavia
Discussion Group

Antonio Ambrosini	John A. Johnson
Andrew G. Haley	Alex Meyer

✦Working Group VI, Eugene Pepin, Paris, France.
✦Working Group VII, Andrew G. Haley, Haley, Wollenberg & Bader, Washington, D. C.
✦Working Group VIII, Robert Homburg, Paris, France.
✦Working Group IX, Spencer M. Beresford, U. S. House of Representatives, Washington, D. C.

FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE

International Institute of Space Law

Session V

2:30 p.m. — South Room

Chairman: John Cobb Cooper, International Law Association, Princeton, N. J.
Vice-Chairman: Alex Meyer, Univ. of Cologne, Cologne-Lindenthal, Germany.

✦Working Group I, John Cobb Cooper, International Law Association, Princeton, N.J.
✦The Search for Agreement on the Rule of Law in Outer Space, Beatty A. Rosevear, McGill Univ., Montreal, Canada.
✦Exploration of Outer Space and Neutrality, Alex Meyer, Univ. of Cologne, Cologne-Lindenthal, Germany.
✦The Space Age and National Power, Jiri Nehnevajsa, Univ. of Pittsburgh, Pittsburgh, Pa.
✦Space Law and National Boundaries, Ronald Christensen, IBM World Trade Corp., New York, N. Y.

EXPLORATION OF THE SOLAR SYSTEM BY RADAR AND RADIO ASTRONOMY—SESSION II

Lee, Potomac, and Arlington Rooms
2:30 p.m.

Chairman: Herbert Friedman, U.S. Naval Research Laboratory, Washington, D.C.

Jupiter

✦Radiation Belts, Gordon Stanley, California Institute of Technology, Pasadena, Calif.
✦Non-Thermal Emission, F. D. Drake, National Radio Astronomy Observatory, Green Bank, W. Va., and J. Warwick, High Altitude Observatory, Climax, Colo.
✦Meteors, T. R. Kaiser, Univ. of Sheffield, Sheffield, England.
✦Solar Radar, V. R. Eshleman, Stanford Univ., Stanford, Calif.

Future Experiments

✦Large Antennae, E. McClain, U.S. Naval Research Laboratory, Washington, D.C.
✦Space Vehicles, E. Lilley, Harvard Univ., Cambridge, Mass., and F. Haddock, Univ. of Michigan, Ann Arbor, Mich.
✦Incoherent Scatter-Radar, K. Bowles, Central Radio Propagation Laboratory, Boulder, Colo.

Discussants:

R. Gallet, Central Radio Propagation Laboratory, Boulder, Colo.
T. Gold, Cornell Univ., Ithaca, N.Y.
R. Jastrow, National Aeronautics and Space Administration, New York, N.Y.
Z. Kopal, Univ. of Manchester, Manchester, England.
M. Nicolet, Institute Royal Meteorologique de Belgique, Uccle, Brussels, Belgium.
E. Opik, Univ. of Maryland, College Park, Md.
C. Sagan, Univ. of California, Berkeley, Calif.
S. F. Singer, Univ. of Maryland, College Park, Md.

BIOASTRONAUTICS—SESSION II

2:30 p.m. — Persian Ballroom I

Co-Chairmen: R. Grandpierre, Centre di Enseignement et de Recherches de Medecine Aeronautique, Paris, France.
Capt. Ashton Graybiel, U.S. Naval School of Aviation Medicine, Pensacola, Fla.

✦Psychophysiology, Lt. Col. David G. Simons, School of Aerospace Medicine, USAF Aerospace Medical Center, Brooks AFB, Tex.
✦Psycho-Physiological Reactions to Weightlessness as Observed on Subjects During Recent Bioballistic and Biosatellite Experiments, Harald J. von Beckh, Aeromedical Field Laboratory, Air Force Missile Development Center, Holloman AFB, N.M.
✦Information Filtering in Quick-Reaction Human Monitored Systems, Norman S. Potter, Maxson Electronics Corp., New York, N.Y.
✦Analysis of Missions of Multi-Man Space Crews in Relation to time in Space and Space Task Performance, Julius Peters, Republic Aviation Corp., Farmingdale, N.Y.
✦Flight Safety Systems for Advanced Manned Space Missions, T. F. Heinsheimer, General Dynamics/Astronautics, San Diego, Calif.

HIGH PERFORMANCE COMBUSTION SYSTEMS

(Panel)

2:30 p.m. — Persian Ballroom II

Moderator: Martin Summerfield, Princeton Univ., Princeton, N.J.

The purpose of this panel discussion is to point out some combustion problems of current importance in high speed propulsion systems employing chemical fuels. In general, the prepared discussions are expected to indicate the present state of knowledge, the important unsolved problems, and some promising directions for research that may lead to useful solutions. Participation by the audience on an international basis will be encouraged.

Friday, October 6

SPACE COMMUNICATIONS ROUNDTABLE

9:00 a.m. — Persian Ballroom I

Chairman: Eberhardt Rechtin, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

✦Colidar, a Light Radar, George F. Smith, Hughes Research Laboratories, Malibu, Calif.
✦Ultracom, Ultraviolet Communications, J. W. Ogland, Westinghouse Electric Corp., Baltimore, Md.
✦Gamma Ray Communications, J. W. Eerkens, Aerospace Corp., Los Angeles, Calif.
✦Measurement of Very Low Frequency Propagation by Lofti I Satellite, J. P. C. Leiphart, U.S. Naval Research Laboratories, Washington, D.C.
✦Light Communications, G. C. B. Garrett, Bell Telephone Laboratories, Murray Hill, N.J.

VEHICLES

9:00 a.m. — Persian Ballroom II

Chairman: Edwin G. Czarnecki, Boeing Co., Seattle, Wash.
Vice-Chairman: Max L. Williams, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif.

✦Blue Streak as First Stage of a Satellite Launcher, G. K. C. Pardoe, The de Havilland Aircraft Co., Ltd., London, England.
✦The Manned Rocket Vehicle, Mercury-Redstone, E. P. Bertram, National Aeronautics and Space Administration, Cape Canaveral, Fla., and J. P. Kuettner, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Ala.
✦Comparison of Lunar and Martian Mission Requirements and Payload Conversion Factors, H. H. Koelle, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Ala.
✦Structures for Solid Propellant Motors, Col. B. Dorleac, Sereb, Paris, France.

(CONTINUED ON PAGE 80)

U.S. space-flight program in review

200 exhibits planned for Coliseum . . . Mercury capsule, full-scale Saturn booster and F-1 engine, communications and weather satellites, and Dynasoar and Snap-2 scale models to be among highlights

By Lawrence Craner Jr.
ARS EXHIBITS MANAGER

THE ASTRONAUTICAL EXPOSITION at the ARS SPACE FLIGHT REPORT TO THE NATION, to be held at the New York Coliseum October 9–15, is already shaping up as the largest exhibit of space-flight systems, subsystems, components, equipment, materials and processes ever held.

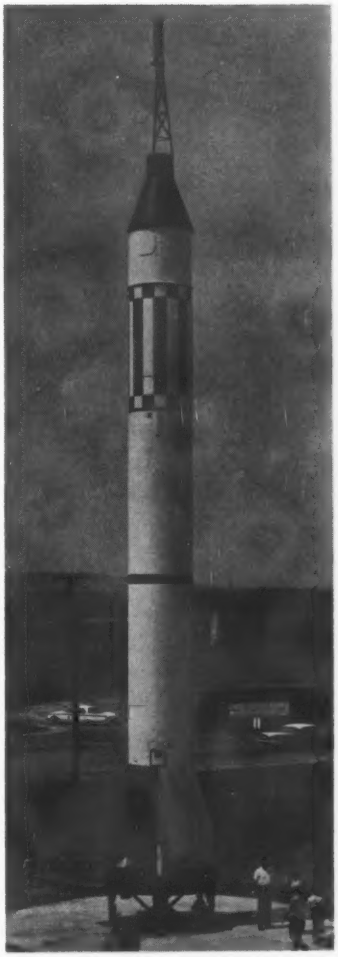
More than 200 exhibitors will have displays at the Exposition, which will spread over three entire floors of the Coliseum, and which has been planned to allow the 15,000 scientists and engineers who will attend the meeting, as well as the public, to witness a full-scale review of the U.S. space program.

In addition to the spectacular NASA exhibit, focal point of the displays on the main floor of the Coliseum, where full-scale mockups and scale models of present and future NASA vehicles and spacecraft will be spotlighted, eye-catching exhibits, especially prepared for the Exposition, are being arranged by a number of companies.

For example, North American Aviation will show a full-scale mockup of the 1.5-million-lb-thrust, single-chamber F-1 engine for the Nova vehicle, while its Rocketdyne Div. will exhibit a full-scale Saturn engine cluster. Bell Telephone Systems will display working models of advanced communication satellites, and will suspend an Echo satellite model above its exhibit and bounce radio signals off it and return them to receivers in the booth to demonstrate how a worldwide satellite communications system might work. RCA will perform a similar experiment using the Tiros weather satellite, with Tiros TV cameras scanning the entire main floor of the Coliseum and transmitting the image to TV receivers in its booth.

Project Mercury will have a prominent place in a number of exhibits. NASA will display a cutaway Mercury capsule, as well as a 40-ft panel graphically depicting the engineering research involved in development of the capsule. McDonnell Aircraft will exhibit a full-scale capsule, complete with escape tower, and the contour couches used in the Mercury suborbital flights of Alan Shepard and Gus Grissom and in the successful flight of Ham, the monkey. The McDonnell booth will also feature a color movie showing astronaut Shepard during his flight.

Mercury will also be featured in two special displays designed to inform New Yorkers of SFRN. A Mercury capsule contributed by



Mercury-Redstone rocket will be on display at Columbus Circle, renamed "Space Flight Circle," adjacent to Coliseum, during week-long meeting.

McDonnell will be available for inspection by the public in Times Square, renamed "Space Flight Square" for the occasion, from Oct. 2 to Oct. 15. Also, a full-size Redstone rocket, with the Mercury capsule and escape tower in place, will be displayed in Columbus Circle, adjacent to the Coliseum, and rechristened "Space Flight Circle," for the week-long meeting.

The GE exhibit will feature a 15-ft display of quarter-scale satellites in orbit around earth, and a full-scale Advent communications satellite. Hughes will show a full-scale model of the Surveyor soft-landing lunar vehicle, while Thompson Ramo Wooldridge will exhibit its "Image Converter" camera, with the fastest shutter ever built—three-billionths of a second—capable of taking photos of bullets in flight and providing a print in a matter of seconds. United Aircraft will show a cutaway mockup of the United Technology segmented solid rocket and the Pratt & Whitney RL-101 liquid hydrogen engine for Centaur.

These are only a few of the more spectacular exhibits scheduled for the Exposition. Many more are still in the planning stages, such as scale models of systems such as Dynasoar, Snap-2, etc.

All in all, the SPACE FLIGHT REPORT TO THE NATION Exposition is already shaping up as the most impressive look to date at where we stand in space. ♦♦

Partial List of Exhibitors

Academic Press
ACF Industries
Acoustica Associates
Aerojet-General Corp.
Aeroquip Corp.
Aeroscience, Inc.
Aerospace Corp.
Airborne Instruments Lab. Div. of Cutler-Hammer
Aircraft & Missiles
Allied Chemical
Aluminum Co. of America
Amcel Propulsion
American Machine & Foundry Co.
American Optical Co.
Atlantic Research Corp.
Avco Corp.
Aviation Week
Avica Corp.
Ball Brothers Research
Barber-Colman Co.
Barnes Engineering Co.
Beckman Instruments
Beckman & Whitley
Bell Aerosystems Co.
Bell Telephone Systems
Bendix Corp.
Beryllium Corp.
Black, Sivalls & Bryson, Inc.
Blaw-Knox
Boeing Co.
Borg-Warner Controls Div. of Borg-Warner Corp.
Bramley Machinery Corp.
Brooks & Perkins
Burroughs Corp.
Callery Chemical Co.
Chance-Vought Corp. (Astro Div.)
Chandler Evans Corp.
Chrysler Corp. (Defense Operations Div.)
Curtiss Wright Corp.
Designers for Industry
Deutsch Fastener Corp.
Donner Scientific Co.
Douglas Aircraft Co.
Edmund Scientific Co.
Electro-Optical Systems
Electro Tec Corp.
Electro-Thermal Industries
Firewel Co.
Flodyne Controls
Garrett Corp.
General Astrometals
General Dynamics/Astronautics
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co.
General Motors Corp.
General Precision
Globe Industries
B. F. Goodrich Co.
Grand Central Rocket Co.
Grumman Aircraft Corp.
Haveg Industries
Heinicke Instruments Co.
Hi-Shear Corp.
Hughes Aircraft Co.
IBM Federal System Div.
Johns-Manville Sales Corp.
Kollsman Instrument Corp.
Lear, Inc.
LeFiell Mfg. Co.
Librascope Div. of General Precision
Linde Co., Div. of Union Carbide Corp.
Lionel Corp.
Litton Systems
Lockheed Missiles and Space Co.
Lukens Steel Co.
Magnaflux Corp.
Marotta Valve Corp.
Marquardt Corp.
Martin Co.
McCormick Selph Associates
McDonnell Aircraft
Metco
Minneapolis-Honeywell Regulator Co.
MSA Research
National Research Corp.
Naval Propellant Plant
North American Aviation
Northrop Corp.
Ordnance Associates
Packard Bell Computer Corp.
Pergamon Press
Perkin-Elmer Corp.
Philco Corp.
Plasmadyne Corp.
Potter Aeronautical Corp.
Prentice-Hall
Radiation, Inc.
Radio Corp. of America
Raybestos-Manhattan
Raytheon Co.
Republic Aviation Corp.
Resistoflex Corp.
Rocketdyne Div. of North American Aviation
Rocket Power, Inc.
Rohr Aircraft Corp.
Royal Research Corp.
Schonstedt Engineering Co.
Scientific American
Scientific Industries, Inc.
Sealol
Space Aeronautics
Space Age News
Space Electronics Corp.
Space Technology Laboratories
Sperry Rand Corp.
Stauffer Chemical Co.
Sunstrand Aviation
Taber Instrument Corp.
Technology Instrument Corp. of Acton (Space Instrumentation Div.)
Tempil Corp.
Texaco Experiment, Inc.
Thiokol Chemical Corp.
H. I. Thompson Fiber Glass Co.
Thompson Ramo Wooldridge
Unilectron
United Aircraft Corp.
United Systems
Vitro Corp. of America
Walter Kidde & Co.
Waugh Engineering Div. of Foxboro Co.
Westinghouse Electric Corp.
E. B. Wiggins Oil Tool Co.
Wyman-Gordon Co.
Wyle Laboratories

ARS Space Flight Report to the Nation

OCTOBER 9—15, 1961

Application For Hotel Accommodations

Please fill out this application form completely and mail it to:

Miss Sylvia Peltonen, Secretary
ARS Housing Committee
90 East 42 Street
New York 17, N. Y.

HOTEL	SINGLE	DOUBLE	TWIN BEDS
ABBEY, 151 West 51st St.	8.00- 9.00	10.50-12.50	12.50-14.50
*BARBIZON-PLAZA, 106 Central Pk. So.	13.50-15.50		17.50-21.50
*BARCLAY, 111 East 48th St.	15.50-21.50		23.50-27.50
*BELMONT PLAZA, Lexington Ave. & 49th St.	8.50-16.00	14.00-19.00	16.00-20.00
*BILTMORE, Madison Ave. & 43rd St.	8.00-20.00	15.00-25.00	15.00-25.00
*COMMODORE, Lexington Ave. & 42nd St.	8.50-16.50	14.00-20.50	15.00-23.00
*DIXIE, 250 W. 43rd St.	9.00-12.00	12.00-15.00	13.00-17.00
*EDISON, 228 W. 47th St.	8.00-11.00	13.00-18.00	15.00-21.00
*ESSEX HOUSE, 160 Central Park So.	All Space Reserved		
*GOVERNOR CLINTON, 7th Ave. & 31st St.	10.00-14.00	14.00-20.00	14.00-20.00
*HENRY HUDSON, 353 W. 57th St.	8.00-11.00	12.00-16.00	13.00-18.50
*MANGER VANDERBILT, Park Ave. & 34th St.	8.50-21.00	13.00-21.00	15.50-21.00
*MANHATTAN, 8th Ave. & 44th St.	9.00-14.00	14.00-18.00	15.00-18.50
*MAYFLOWER, Central Pk. W. & 61st St.	12.00-16.00		14.00-17.50
NEW YORKER, 8th Ave. & 34th St.	8.00-14.50	11.50-18.00	15.50-20.00
PARAMOUNT 235 West 46th St.	8.00- 9.00	10.00-12.00	12.00-14.00
PARK LANE, 299 Park Ave.	19.00	24.00	24.00
*PARK-SHERATON, 7th Ave. & 55th St.	11.00-16.00		15.00-20.00
*PIERRE, 2 East 61st St.			24.00-30.00
*PLAZA, 5th Ave. & 59th St.			23.00-30.00
*ROOSEVELT, Madison Ave. & 45th St.	8.50-20.00	13.50-24.00	17.50-25.00
*ST. MORITZ, 50 Central Park So.	13.00-16.00		16.00-20.00
*SAVOY HILTON, 5th Ave. & 58th St.	19.00		23.00
*SHERATON-ATLANTIC, Broadway & 34th St.	9.00-14.00	13.00-17.00	14.00-18.00
*SUMMIT, Lexington & 51st St.	14.00-30.00	16.00-32.00	18.00-34.00
TAFT, 7th Ave. & 50th St.	10.75		17.50
VICTORIA, 7th Ave. & 51st St.	9.00- 9.50	12.50-13.00	14.50-16.00
*WALDORF-ASTORIA, 301 Park Ave.	12.00-20.00	18.00-28.00	18.00-28.00
*WARWICK, 65 West 54th St.	18.00		22.00
*WELLINGTON, 7th Ave. & 55th St.	8.50-12.50	13.00-18.00	13.00-18.00
WOODSTOCK, 127 W. 43rd St.	7.00- 9.00	10.00-14.00	10.00-14.00

Rates subject to 5% New York City tax on hotel rooms. *Suites available. For reservations contact housing bureau.

——————————CUT ALONG THIS LINE——————————

Hotel Accommodations Desired. (It is necessary that five choices of hotels be listed below:)

INDICATE APPROXIMATE RATE AS SHOWN IN SCHEDULE

		TYPE OF ROOM DESIRED		
CHOICE	HOTEL	SINGLE 1 PERSON	ONE DOUBLE BED— 2 PERSONS	TWIN BEDS 2 PERSONS
1st				
2nd				
3rd				
4th				
5th				

If accommodations are not available at any of the above hotels, reservations will be made at some other suitable hotel.

NAME..........

AFFILIATION..........

ADDRESS (Home/Bus.)..........

CITY.......... STATE..........

DATE ARRIVING.......... ARRIVAL HOUR.......... DATE DEPARTING..........

Please list names, affiliations and desired accommodations for additional persons on separate sheet and attach to this form.

NOTE: There will be an interval of several weeks before you can expect to receive a direct confirmation from the hotel accepting your reservation. Room numbers cannot be assigned by hotels until guests register on arrival.

MAKE YOUR RESERVATION NOW

Initial group of 721 Senior Members named by ARS special committee

THE FOLLOWING individuals have been selected by a special committee to be the charter Senior Members of the American Rocket Society. All Member grade ARS members are being sent Senior Member grade applications so that they may apply should they feel qualified. The names of all ARS Fellow Members are also included in this listing so that those applying for Senior Member grade may have their names should they wish to use them as references.

The committee, which was appointed by the ARS Board of Directors, was, of course, not able to name all persons qualified for the new grade, but only those known to them.

New Senior Members' names will be published in *Astronautics* each month.

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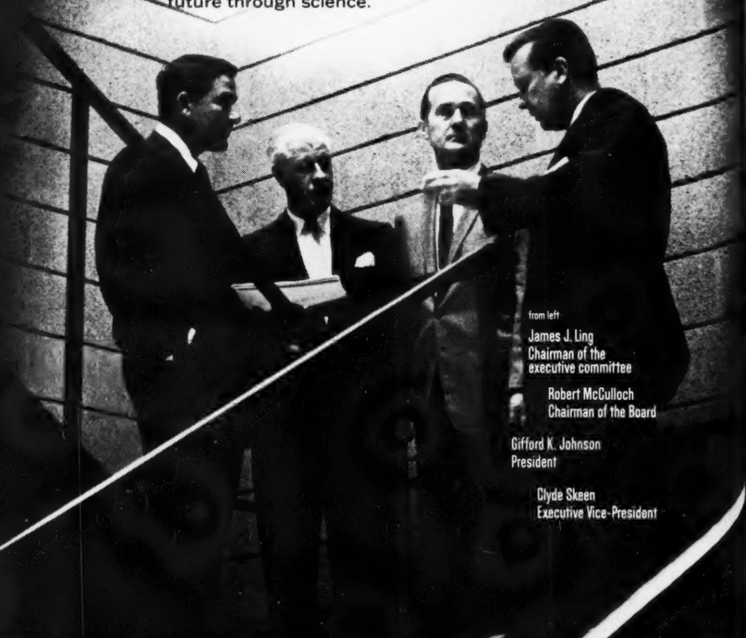

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posed new name for the combined companies after August 31, 1961. CHANCE VOUGHT CORPORATION AND LING TEMCO ELECTRONICS, INC

Ranger Spacecraft

(CONTINUED FROM PAGE 25)

roll axis of the craft toward the Sun, using small optical sensors, gyros for rate stability, and tiny nitrogen-gas jets. Following Sun acquisition, the spacecraft rolls slowly until light reflected from the Earth is detected by a sensor that moves with the antenna. Error signals from this sensor direct the antenna beam toward the Earth, and the spacecraft then continues to coast in a stabilized attitude until the end of its mission, nominally a month or two after launching. There is a possibility that the earth sensor might acquire the Moon by mistake. In this event, radio override commands can be sent to make the spacecraft resume its search for the Earth. The commands are received through an omnidirectional antenna mounted at the top of the instrument-bearing superstructure that constitutes the Ranger 1 and 2 mission package.

Battery Is Included

A large battery is carried in the center of the hexagonal bus. In the event of an attitude-control failure and consequent loss of solar power, this battery would power the spacecraft for a sufficient period of time to permit transmission of a large quantity of diagnostic telemetry. Also, there is on board the spacecraft a separate, independently-powered small transmitter which can send telemetry up to a limited range via the omnidirectional antenna even if all other subsystems fail.

The flight of Ranger 1 demonstrated most of this functional sequence in spite of the fact that only a low-altitude satellite orbit was achieved instead of a desired highly elliptical orbit.

For Ranger 3, 4 and 5 the tall superstructure is replaced by a mission package consisting of a vidicon television camera, a lunar gamma-ray sensor and spectrum analyzer, and the rough-landing retrocapsule subsystem described elsewhere in this issue by Frank Denison. The big battery is replaced by a mid-course maneuvering rocket, and the simple command system of Ranger 1 and 2 is replaced by a more elaborate system capable of addressing quantitative maneuvering orders to the spacecraft.

The flight operating sequence is as follows: Initial acquisition of the Sun and Earth occurs as before; then, after a number of hours of tracking, a trajectory correction is computed and sent to the spacecraft. The craft abandons its Sun and Earth references and makes a gyro-controlled turn to the direction of the required maneuver. The mid-course rocket, a 50-lb-thrust monopropellant-hydrazine propulsion unit, is then ignited and burns until an integrating accelerometer senses that the requisite speed has been gained. At this point, thrust is terminated and the spacecraft reacquires the Sun and Earth.

About two days later, as the spacecraft nears the Moon, another set of commands is sent, this time to align the roll axis of the spacecraft back along the velocity vector to provide the proper orientation for the television camera and to give the correct launching direction for the capsule retrorocket. When the capsule radar altimeter signals firing of the retrorocket, the capsule separates and the bus travels on to an unbraked impact on the Moon.

Rangers Are Complex

It can be seen from these descriptions that the Rangers are quite complex and that their design presents a number of uncertainties as to environment, subsystem interactions, and so forth. Also, the opportunities for the use of redundant or fail-safe designs are relatively few, since the lunar-flight mission fundamentally consists of a long sequence of functions in series. By forcing ourselves to operate in such an unfavorable environment from the standpoint of reliability, we are learning the techniques which will enable us in the future to design and build with confidence for the performance of even more ambitious missions to the Moon. At the same time, if we succeed in making all the links of the long chain work, we will produce new and definitive data that will help in planning for the eventual takeoff of a lunar astronaut. ◆◆

70 Papers Presented At 3rd Japan Space Symposium

The Third International Symposium on Rockets and Astronautics, sponsored by the Japanese Rocket Society and held at the Nippon Toshi Center in Tokyo Aug. 28–Sept. 1, witnessed the presentation of 70 papers, with about half of these given by non-Japanese authors. The papers were presented at 12 technical sessions, four of these being devoted to vehicles and one each to space law, space medicine and biology, propellants, space science, propulsion, reliability and instrumentation. Prof. Noboru Takagi of the Institute of Industrial Science, Univ. of Tokyo, was the meeting chairman.

International scene

By Andrew G. Haley

THE INTERNATIONAL Academy of Astronautics, organized at Stockholm last year by Theodore von Kármán and Frank J. Malina, has functioned throughout the intervening period, and the first regular meeting will take place in Washington, D. C., Oct. 3, 1961, on the occasion of the XIIth Annual Congress of the International Astronautical Federation.

The Academy has maintained a Secretariat in Paris, the premises of which were donated by the French Government, located at 12, Rue de Gramont. Initial funds to defray the costs of operation were provided by the Daniel and Florence Guggenheim Foundation.

A strong movement exists to consolidate the Secretariat into one working unit to serve the Federation itself, as well as the Academy of Astronautics and the International Institute of Space Law. Each of these activities would pay its equitable share of the costs of maintaining the Secretariat.

The Academy Nominating Committee, composed of Luigi Broglio (Italy), Irene Sänger-Bredt (Germany) and Andrew G. Haley (USA), has suggested the following list of nominations:

Director: Theodore von Kármán (USA). Deputy Directors: F. J. Malina (USA) and J. Peres (France). Trustees for Section1: N. Boneff (Bulgaria), one year; A. Ehmert (W. Germany), Chairman of Section 1, two years; J. Kaplan (USA), one year; and Sir Bernard Lovell (UK), two years. In Section 2: E. A. Brun (France), one year; A. Eula (Italy), one year; J. M. J. Kooy (Netherlands), two years; and R. Pesek (Czechoslovakia), Chairman of Section 2, two years. For Section 3: M. Florkin (Belgium), Chairman of Section 3, two years. W. R. Lovelace II (USA), two years; and A. Meyer (W. Germany), one year.

* * *

The Eleventh Annual Assembly of the Advisory Group for Aeronautical Research and Development (AGARD) of the North Atlantic Treaty Organization was held in Oslo July 24–29 under the chairmanship of Dr. T. von Kármán. More than 400 scientists from NATO nations attended the meeting.

The round-table discussion, held July 27, was moderated by Finn Lied of Norway, the subject being "Scientific Aspects of Space Technology." Specifically treated were "Space Communications," under W. F. Hilton, Head, Astronautic Div., Hawker Siddeley Aviation, Ltd. (UK); "Space Physics," under Herbert Friedman, Superintendent, Atmosphere and Astrophysics Div., Naval Research Laboratory (USA); and "Space Medicine," under Dr. Lovelace, Director, Lovelace Foundation, and Member-Project Mercury (USA).

Panel meetings were also held on aerospace medicine, avionics and fluid dynamics.

The official membership of AGARD is:

Chairman: Dr. von Kármán; *Vice-Chairman:* E. T. Jones

Members:

Belgium: M. Freson, F. Haus
Canada: J. L. Orr, F. R. Thurston
Denmark: Col. P. N. Brandt-Moeller, K. Refslund
France: J. Peres, M. Roy, Ingenieur en Chef de Coligny
Germany: Th. Benecke, F. Bollenrath
Greece: M. Anastassiadis, Col. N. Papademetriou
Italy: Gen. C. Alippi, G. Gabrielli
Netherlands: H. J. van der Maas, A. J. Marx
Norway: F. Lied
Portugal: Col. J. A. de Almeida Viama
Turkey: Col. S. Isimer, Gen. F. Ulug
United Kingdom: Sir William S. Farren, E. T. Jones, M. B.Morgan
United States: H. L. Dryden, Gen. D. L. Putt, Dr. von Kármán

* * *

The following report on the Commission on Astronautics of the Czechoslovak Academy of Sciences has recently been received from Commission Chairman, Rudolf Pesek.

The Commission was organized on Jan. 1, 1959, by the technical section of the Czechoslovak Academy of Sciences (CAS), of which the Commission is a part. The basic task of the Commission is the coordination of the activities of scientific institutions and of individual scientists working in the domain of astronautics in Czechoslovakia and to promote their collaboration.

The CAS research institutes have organized satellite tracking activities, using both optical and electronic techniques, in cooperation with IGY and IGC work, while the Commission has established working groups for Space Medicine, Space Law, and Meteorological Research by means of satellites, and is preparing further groups to solve the problems of other branches of astronautics.

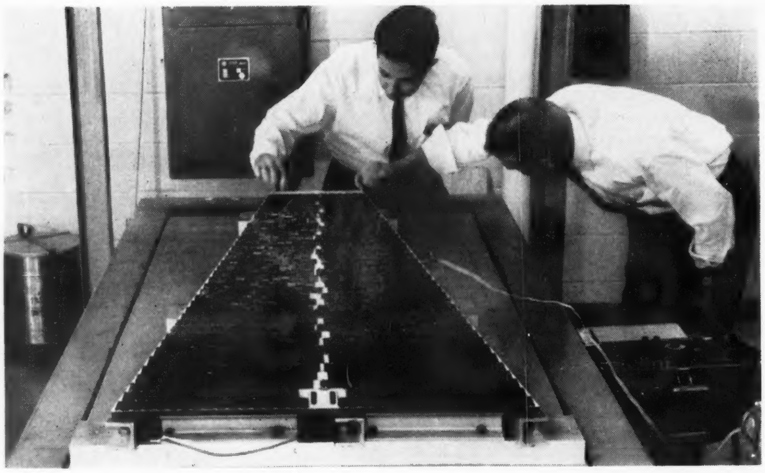
In April, 1960, the first Czechoslovak Conference on Rocket Technique and Astronautics, organized by the Commission, took place in the CAS House at Liblice, near Praha, with 24 papers presented covering the basic sciences, engineering sciences, space medicine, and space law. The next conference is scheduled for April, 1962. This year, as in previous years, the Commission has sponsored regular lectures on astronautics.

In an effort to continue in the tradition of international cooperation which was demonstrated in the IGY, the Commission is cooperating in the program of meteorological research by means of U.S. Tiros weather satellites. The work is carried out by the different CAS institutes and is coordinated by the Commission.

Officers of the Commission are Dr. Pesek, Chairman, and Council members E. Buchar, J. Stransky, F. Behounek, F. Link, V. Guth, S. Djadkov, S. Servit and V. Kopal. ♦♦

Proceedings of 2nd Japanese Space Symposium Available

The Proceedings of the Second International Symposium on Rockets and Astronautics sponsored by the Japanese Rocket Society and held in Tokyo in May 1960 are now available. The 344-page, soft-cover, offset-printed volume contains 56 papers presented at the meeting, divided into chapters covering propellants and propulsion, vehicles, instrumentation, space science, and a miscellaneous category. The volume may be obtained from the Institute of Industrial Science, Univ. of Tokyo, Yayoi-cho, Chiba City, Tokyo, Japan, at a cost of 1500 yen, or $4.50.



Solar Power for Ranger

Engineers of Hoffman Electronics check out a Ranger solar-power panel prepared in a cooperative program with JPL. Each panel carries 4340 silicon solar cells, weighs 19 lb, and can deliver 90 watts. The cells interconnect in a manner that localizes power loss from micrometeorite damage.

Ranger Lunar Program

(CONTINUED FROM PAGE 22)

which missed the Moon by a wide margin and went into orbit around the Sun. These Pioneers provided a good deal of additional information about the Van Allen Belt, which had been discovered with the Explorer satellites.

Between Pioneers III and IV, on Jan. 2, 1959, the Soviets launched Lunik I. This was obviously an attempt to hit the Moon. After a near miss of the Moon, Lunik I went into orbit about the Sun. On Sept. 13, 1959, the Soviets made a direct hit on the Moon. On Oct. 4, 1959, they launched Lunik III, which photographed the far side of the Moon. Both of the shots were well timed to enhance the prestige of Khrushchev during his tour of the U.S.

On Nov. 26, 1959, an attempt to use an Atlas-Able combination to send a payload to the Moon was unsuccessful. Further attempts to orbit the Moon, with the Atlas-Able as a booster, on Sept. 25, 1960, and Dec. 15, 1960, were also unsuccessful. The payload for these attempts was an outgrowth of that used in Pioneer V, which still holds the communication record of more than 26-million miles.

The U.S. lunar-probe attempts of the past have utilized relatively lightweight spinning payloads. With the Ranger series, a class of spacecraft for lunar and planetary exploration is being utilized.

The key to this new class of spacecraft is full attitude stabilization for the entire flight. Incorporating this feature is now possible because of the weight-lifting capability of the Atlas-Agena B injection vehicle (Ranger 1 weighs 675 lb). Atlas-Agena B is described by Harold Luskin and Friedrich Duerr elsewhere in this issue.

Benefits of attitude-stabilized spacecraft exploited in Ranger include the following:

1. The solar panels are accurately pointed at the Sun to achieve maximum effectiveness in generating power.
2. An accurate angle-reference system is made available as a coordinate system in which a midcourse manuever is made to trim the flight path and as a reference for firing the retro-capsule when approaching the Moon.
3. A high-gain antenna is precisely pointed toward the Earth, so that relatively wide-band data can be transmitted from the spacecraft to the Deep Space Instrumentation Facility, which is discussed by Nicholas Renzetti on page 34.
4. Scientific experiments which require determination of direction now have the appropriate "bus" for their ride into space.

The first two Ranger flights are designed principally to test the fundamental spacecraft engineering features which will be basic bus techniques and hardware for later Rangers. This same technology will be exploited in the Mariner A series of spacecraft when they take off for Venus.

Because their purpose is to test engineering technology, the first two Rangers are not intended to go toward the Moon. Though Ranger 1 went into a low earth orbit rather than a deep-space trajectory, it achieved its mission by demonstrating a successful attitude-control system, proving a reliable communication system and returning important scientific data.

The first two Rangers carry a number of scientific experiments to exploit the attitude-stabilization feature of the Ranger. Measurements will be made on fields and particles in space and the neutral hydrogen cloud around the Earth.

Next year, three more Rangers are expected to make the trip to the Moon. These will carry a small seismometer and transmitter to send back data from the surface of the Moon after surviving a limited speed impact provided by the Aeronutronic capsule, which is described by Frank Denison in this issue. As the busses for these missions approach the Moon, they will send back readings from a gamma-ray spectrograph and successive photos of the lunar-impact area.

More details on the Ranger spacecraft and its function appear in the article on page 23, by James Burke, Ranger Project Manager.

The Ranger spacecraft has the potential of carrying other lunar and near-space experiments. This capability may well be utilized in the next few years to advance the over-all objective of manned lunar exploration. Ranger technology and data obtained about the Moon will materially contribute to the Surveyor and Prospector projects, both of which are expected to make major steps along the path to our new goal—landing a man on the Moon and returning him before the Soviets do. ♦♦

Bio-Astronautics Bibliography

The Office of Technical Services of the Commerce Dept. is offering a new OTS Selective Bibliography which lists government research reports, translations, and other technical documents on bio-astronautics placed in the OTS collection between January 1959 and April 1961. Copies of the bibliography may be obtained at 10 cents each by writing to OTS, U.S. Department of Commerce, Washington 25, D.C.

Preparing Ranger

(CONTINUED FROM PAGE 29)

operation of the entire Ranger system. The Ranger "system" may be defined here as including the launch control and checkout equipment in the blockhouse and at the launch pad, the Atlas, the Agena, and the Ranger spacecraft.

Safe system operation may be divided into three major areas—structural, electrical and RF interface. As individual groups, the designers of the Atlas, Agena, and Ranger have solved their structural, electrical, and RF-interference problems. This might no longer be true, however, when the three connect structurally and electrically. The mechanical forces attacking the complete launch vehicle, especially during the transonic period, are quite severe, and shroud-configuration changes appearing minor may actually cause buffeting or pressure differentials not accurately predictable and sometimes unpredictable. Consequently, wind-tunnel tests have been run to take data for design calculations.

A similar condition exists in the electrical interface. When four electrical systems (Launch Control, Atlas, Agena, Ranger) with a number of different power supplies are interconnected, the chances of shorts, grounds, or sneak circuits are increased. Moreover, when more-or-less independent systems of these types are connected, an occurrence, such as inductive "kick" from a relay coil, in one system, having no effect whatsoever in that system, may trigger an event in one of the connected systems. The event may be either completely spurious or out of normal sequence. The seriousness of such interaction is obvious.

Also critical is the possibility of RF interference. Particularly during the ascent trajectory, a number of RF components may be radiating simultaneously, and every precaution must be taken that the signal for one function does not trigger some unexpected function in another system—for example, a destruct circuit which would destroy the launch vehicle. A part of the test program to be discussed now was designed to detect any such interference.

Generally, the philosophy of solving problems in the Ranger launch-vehicle system is first to treat the problem analytically and to arrive at a theoretical solution. The validity of the analytical results are then verified by testing. Additional testing is conducted for reliability or "confidence" purposes.

Tests have been performed in the fields of vibration, thermal, structural, and spacecraft cooling. A less classical test, the so-called "Smoke" test, has been run to test all material to be used around the spacecraft. The materials, insulation, cement, etc. were subjected to temperatures and pressures expected to be experienced during the ascent phase. The degree to which a material "smokes" was determined by measuring any deposit left on a glass surface. The influence of such deposits on optical portions of experiments was then measured to determine the suitability of the material. Results of these tests revealed the necessity of several material substitutions. All tests were performed under simulated, or as nearly as possible, flight conditions.

Tests also cover components, subsystems and the whole system. These are accomplished at GD/Astronautics, Lockheed Missiles and Space Company, and JPL.

Test Sequence Described

The tests begin with receiving inspection of components from subcontractors to insure proper operation. Then follow subsystem tests performed on assembled subsystems such as guidance. During this test, the subsystem is connected to "bench" or laboratory equipment and calibrated and checked for performance as an assembled subsystem. This test may be conducted with the subsystem installed on the vehicle. Basically, the unit is actuated by a simulated input; and the output-signal level, phase relationship or polarity is compared to standard acceptable figures.

In the system test, a major portion of a launch vehicle, such as Agena, is checked. Here every operation of the Agena during flight is performed, with exception of hot firing the power plant. Another milestone in the checkout is the compatibility test of Agena and spacecraft. In the compatibility test, the spacecraft is mated to the Agena and, as in the system test, subsystems are exercised in sequence and checked for interference. At the same time, RF equipment of the Atlas is operated to check on interference. This test goes far toward verifing the work of the Safe Systems Operation Group.

The last test, before shipment of the Agena to Cape Canaveral, is a static firing at the Lockheed Santa Cruz Test Base. This test is conducted on a sampling basis, with at least the first vehicle of each configuration being test-fired. The Agena with a prototype spacecraft is mounted in a test stand and extensively instrumented to check engine performance, vibration, etc. Flight telemetry pack-

ages are radiating during the firing. Before shipment to the range, another system test of the Agena is performed to check that a flight-ready vehicle is being shipped.

The Atlas vehicle is not static-fired prior to launch. It is, however, subjected to a complete system "acceptance" test before shipment to Cape Canaveral.

Long before the launch vehicle and the spacecraft arrive at the Atlantic Missile Range, extensive preparations are made to be ready with everything that is required for smooth and efficient prelaunch and launch operations. As much as 12 months before firing, the basic requirements related to range support are collected in a book called "Program Requirements Document" (PRD). This document lists the mission objectives and contains necessary technical details of the launch vehicle, launch facilities required, fuel and oxidizer requirements, and requirements for downrange tracking and telemetry stations, which extend, in the Ranger program, over two continents. This document is generated primarily to inform the missile range of requirements it should meet.

Periodically, the PRD is modified and amended according to the latest changes in program. The answers to the requirements stated in the PRD are documented in the "Program Support Plan" (PSP), which tells if and how the range organization can meet those requirements. In addition to these two basic range-use documents, a number of manuals and plans for specialized fields—such as Countdown Manual, Operation Support Plan, Detailed Test Objective, to name a few—are generated to help make the launch a precise operation.

Precision is especially important during countdown, when propellants for the Atlas and Agena have to be on time for loading, last minute checks must be performed, and the flight readiness of the launch vehicle including the spacecraft has to be certified. This is most important in the Ranger program since, for at least one launch, there is only a half-hour period in the day for a limited number of days during a month when the vehicle can be launched to place the spacecraft in the desired orbit.

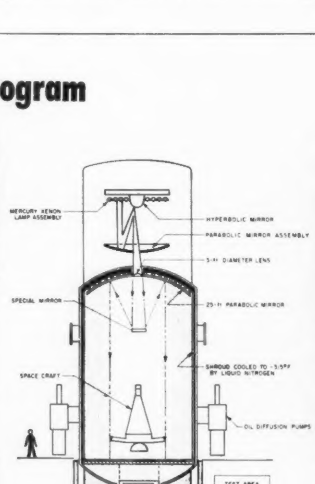
Duties of Range Stations

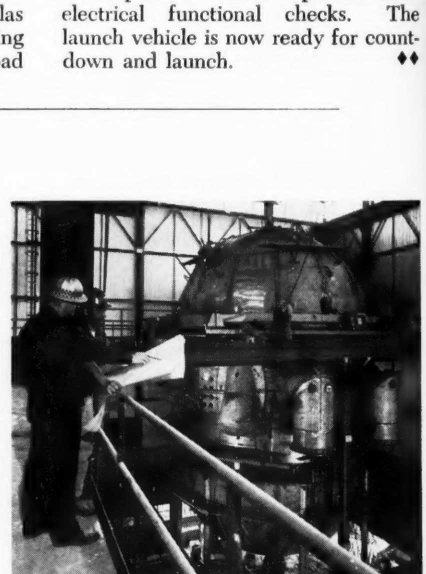
At the same time, the tracking and telemetry stations from Cape Canaveral, down range, must be ready. These stations transmit position, velocity, and operation information to Cape Canaveral for evaluation. Data are checked against the calculated trajectory for range-safety reasons and to give downrange stations acquisition information. The telemetry information gives a "quick look" performance evaluation; final reports come out a few weeks later.

Checkout of the Ranger spacecraft and its launch vehicle at Cape Canaveral is a parallel effort. The Atlas goes first to the hangar for receiving inspection and then to the launch pad for extensive checkout. Pad checks made on the Atlas include blockhouse compatibility, propellant-tanking integrity, engine alignment, autopilot, readiness and, finally, a flight-acceptance composite test. During the Atlas activities on the pad, the Agena is undergoing subsystem tests in another hangar. Concurrently, the Ranger is being validated in the spacecraft hangar. Upon completion of subsystem testing, the Agena is mated to the Atlas at the pad, where blockhouse compatibility checks and Agena systems tests are performed. The Ranger spacecraft is then transported to the pad and mated with the assembled boost vehicle for combined testing, which includes umbilical release tests, combined radiation tests, and Joint Flight Acceptance Composite Tests.

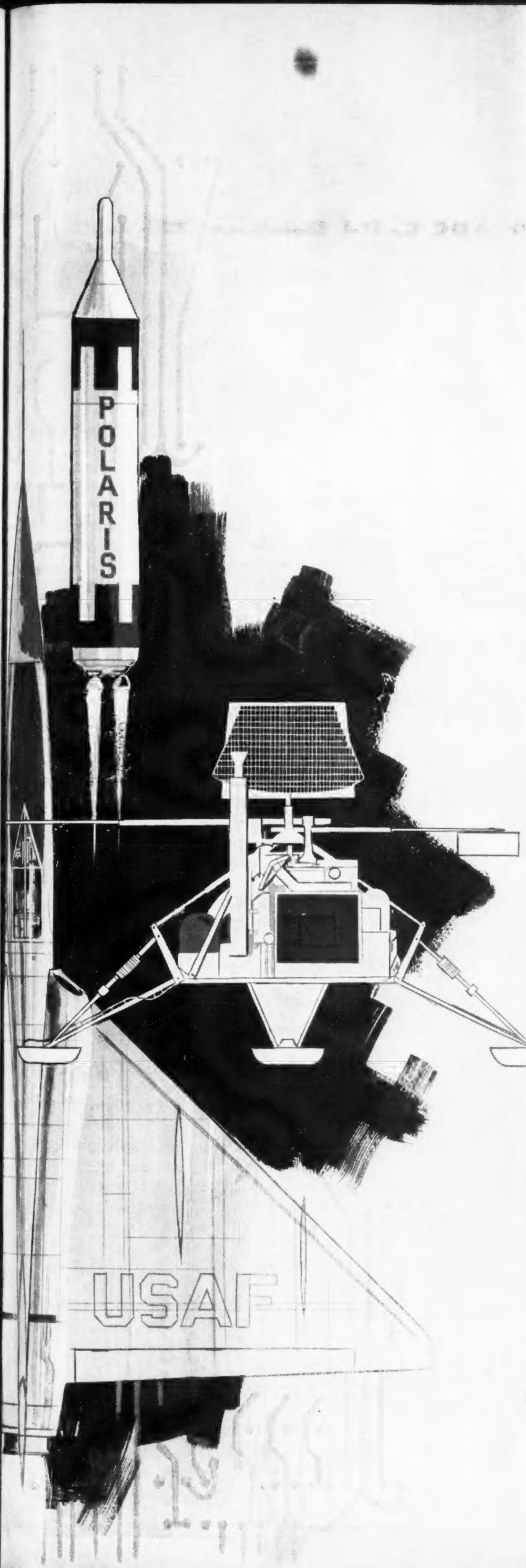
These tests complete, Ranger is demated and returned to the spacecraft hangar. A flight Readiness Demonstration is then performed with Atlas and Agena. This demonstration consists of conducting a complete countdown up to the point of firing. This countdown proves the capability of the facilities and ground-support equipment to launch the vehicle. The Agena is then demated and returned to the hangar for final flight preparations. After final flight preparations and last-minute revalidation, the Agena and spacecraft are again taken to the pad and mated to perform final electrical functional checks. The launch vehicle is now ready for countdown and launch. ♦♦

Giant Simulators Join Space Program





The closest thing to spaceflight for most people might be the opportunity to step inside one of the several giant space simulators springing up in major organizations across the country. Left, cranes emplace the body of a 55-ton chamber primarily for testing Agena spacecraft at Lockheed Missiles and Space Co.; the Lockheed simulator is scheduled to begin operations in November. Center, a sketch depicts the layout of JPL's simulator for testing interplanetary spacecraft; it will go into operation early next year. Right, the chamber of the simulator for GE's new Valley Forge Space Technology Center that will test Nimbus and Advent satellites; this simulator is now in operation. Consolidated Vacuum Corp. is contractor for the Lockheed and JPL simulators.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ARS news

Abstract Deadlines Set for 1962 ARS Solid Rocket, Electric Propulsion, and Structures and Materials Conferences

Abstract deadlines for papers to be presented at the 1962 specialist conferences on Solid Propellant Rockets, Electric Propulsion, and Launch Vehicles Structures and Materials have been announced by the conference chairmen.

Abstracts of papers for the Solid Propellant Rocket Conference, to be held Jan. 24–26 at Baylor Univ., Waco, Tex., must be submitted to Conference Chairman G. Daniel Brewer, Grand Central Rocket Co., Redlands, Calif., by Oct. 20.

Authors wishing to contribute papers to this meeting are asked to submit 300–500 word abstracts. Material of the highest academic interest will be given preference, and subject matter should complement the annual summer JANAF meeting. Tentative Technical Session titles are: Nondestructive testing; explosive classification of motors; use of electronic computers in research, design and development; propellant processing; rocket motors for meteorological sounding purposes; high-performance solid motors; gas dynamics and heat transfer; and effects of environment on rocket motor operation.

Authors desiring to present papers at the Electric Propulsion Conference at the U.S. Naval Postgraduate School, Monterey, Calif., March 14–16, must submit abstracts by Nov. 20 to Eugene Urban, NASA George C. Marshall Space Flight Center, Huntsville, Ala.

Papers will be considered for presentation in the basic areas of electrostatic, electrothermal, and electromagnetic propulsion. The subject matter of the papers must be within the scope of basic research, applied research and development, flight and ground testing, missions, and systems integration. Four sessions will be scheduled each day during the three-day conference.

Contributors to the Launch Vehicles Structures and Materials conference, to be held April 3–5 at Ramada Inn, Phoenix, Ariz., must submit 300–500 word abstracts to Max L. Williams, California Institute of Technology, Pasadena, Calif., before Sept. 15.

The conference will cover advanced structures and materials concepts of nonrecoverable stages, special recovery techniques and equipment, and winged boosters and stages, including propulsion components.

Tentative session topics include: Design criteria, materials of construction, thermodynamics and heat transfer, and structural analysis.

Section Activities Panel Discussion Set for SFRN

All local section officers and board of director members are being encouraged to attend the Section Activities Panel Discussion next month at the ARS Space Flight Report to the Nation in New York City to discuss openly and freely ideas on local section activities. The following ARS members with vast experience in ARS activities have consented to participate in this panel discussion:

Moderator:

H. M. Cook, ARO, Inc. (president, Tennessee Section)

E. W. Smith, North American Aviation (ARS Section Activities Committee)

Jerry Grey, Princeton Univ. (ARS

Section Activities Committee)

R. D. Stewart, NASA (Vice-Chairman, ARS Section Activities Committee)

F. H. Inderwiessen, Mid-West Research (President, Kansas City Section)

L. J. Bornstein, Aerojet-General (Past President, Sacramento Section)

John P. McGovern, Thiokol Chemical Corp. (President, Utah Section)

This is the second such panel discussion and is the direct result of the favorable response to the first one held at the ARS Semi-Annual Meeting in Los Angeles last June. The intent of the panel discussion is to give members an opportunity to present and exchange ideas on section activities on an informal basis.

On the calendar

1961	
Sept. 6–8	IRE National Symposium on Space Electronics and Telemetry, Albuquerque, N.M.
Sept. 7–8	1961 Fall Meeting of Western States Section/The Combustion Institute, Univ. of California, Berkeley, Calif.
Oct. 2–4	Seventh National Communications Symposium of IRE Professional Group on Communications Systems, Municipal Auditorium and Hotel Utica, Utica, N.Y.
Oct. 2–7	**XIIth International Astronautical Congress, Washington, D.C.**
Oct. 4–6	American Society of Photogrammetry Semi-Annual Convention, Biltmore Hotel, New York, N.Y.
Oct. 9–15	**ARS SPACE FLIGHT REPORT TO THE NATION, New York Coliseum, New York, N.Y.**
Nov. 12–17	Conference on Medical and Biological Problems in Space Flight, Nassau, Bahamas.
1962	
Jan. 24–26	ASME Thermophysical Properties Symposium, Princeton Univ., Princeton, N.J.
Jan. 24–26	**ARS Solid Propellant Rocket Conference, Baylor Univ., Waco, Tex.**
March 14–16	**ARS Electric Propulsion Conference, U.S. Naval Postgraduate School, Monterey, Calif.**
April 3–5	**ARS Launch Vehicles Structures and Materials Conference, Ramada Inn, Phoenix, Ariz.**

CHANGE-OF-ADDRESS NOTICE

In the event of a change of address, it is necessary to include both your old and new addresses, as well as your membership number and coding, when notifying ARS Headquarters in order to insure prompt service. If you are moving or have moved, send the following form to Membership Dept., American Rocket Society, 500 Fifth Ave., New York 36, N.Y.

Name______________________________

Membership Card No.____________ **Coding**____________

Old Address______________________________

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New Address______________________________

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Discussions will be "off the record," with primary emphasis on ideas to help the local sections in their ARS programs. The meeting is scheduled for the morning of Tuesday, Oct. 10.

SECTION NEWS

Alabama: The Section held its semi-annual banquet in May at the Huntsville Country Club. Guest speaker was **Mortimer Rosenbaum,** chief engineer of GD/Astronautics, who was introduced by Walter Berry, vice-president of the Section. Present as honored guests were Maj. Gen. **John A. Barclay,** Deputy Commander of AOMC, and Brig. Gen. **Richard M. Hurst,** ABMA Commander.

The title of Rosenbaum's talk was "Project Centaur and Beyond." He predicted that "the Centaur will change the world like Columbus did." The revolutionary changes will come from the jobs Centaur will do in exploring outer space, such as orbiting a 24-hr satellite.

Rosenbaum

Von Braun

In June, **Wernher von Braun,** director of NASA Marshall SFC, spoke to a joint meeting of the local Sections of ARS, RCAA, and IRE on "The Why and the How of Space Exploration," at Redstone Arsenal Rocket Auditorium. He touched on many subjects, including the fundamentals of the Russian and American space programs.

—J. Frank Rushton

Central Colorado: Section officers are now as follows: James G. Gaume, president; J. E. Boretz, vice-president; T. Bradley, secretary; and Roland Glenn Doolittle, treasurer.

—J. E. Boretz

Central Indiana: Continuing its 1961 schedule with a dinner meeting in late May, the Section was privileged to have **Andrew G. Haley,** General Counsel of ARS, as guest speaker on aspects of space law, a subject in which he is internationally recognized as expert. There are three methods generally recognized under international law by which a nation may claim territory, Haley pointed out. These are flag implantation and other

1961–62 ARS Meeting Schedule

Date	Meeting	Location	Abstract Deadline
Oct. 2–7	XIIth International Astronautical Congress	Washington, D.C.	Past
Oct 9–15	ARS SPACE FLIGHT REPORT TO THE NATION	New York, N.Y.	Past
1962 Jan. 24–26	Solid Propellant Rocket Conference	Waco, Tex.	Oct. 20
March 14–16	Electric Propulsion Conference	Monterey, Calif.	Nov. 20
April 3–5	Launch Vehicles Structures and Materials Conference	Phoenix, Ariz.	Sept. 15

symbolic ceremonies, mapping and exploration, and actual conquest or settlement. By landing a flag on the moon with Lunik II, the Russians could have established a territorial claim, although they said then that no claim would be made. With Lunik III a month later, Russia photographically mapped the rear side of the moon. "I asked Soviet scientists if they would use the mapping photos for a moon claim," the speaker reported. "They said they weren't allowed to answer, and they never have." Whichever nation first lands a manned vehicle on the moon will probably have world support for a territorial claim. One aspect of the seriousness of the space race may be seen from the possible power struggle which could result from conflicting territorial claims on the moon.

Haley stressed the need for the social sciences to accompany man into space. Present international agreement on space law is essentially limited to two points—The U.N. charter states that outer space will not be used for staging an attack upon other nations; and, during the IGY, it was agreed that outer space should be used for peaceful purposes only. Beyond this, there is little other than historically accepted rights, such as that of a nation to defend itself if threatened by attack.

Haley concluded his presentation with the first public showing of a new NASA-sponsored motion picture entitled "Life on Other Planets," covering the new field of exo-biology, with discussions by **Joshua Lederberg** of Stanford Univ. and other noted scientists. Recognition of life forms through their ability to reproduce, chemical analysis of possible life forms to detect nucleic acids and proteins, and the design of unmanned exploration equipment to collect and analyze specimens were some of the topics covered in this excellent film.

The Section concluded its spring series with a discussion of direct electrochemical energy conversion by **John J. Lander,** director of the Electrochemical Research Dept., GM's Delco-Remy Div., at a June dinner meeting.

Dr. Lander discussed chemical-battery and fuel-cell technology in terms of specific energy and power capabilities. He pointed out that fuel cells have immediate practical applications in such fields as standby power generation, submarine propulsion, and communications. He speculated that fuel cells will be competitive with diesel engines in some situations within five years and may compete with gasoline engines for the private transportation market within a decade.

—**John P. Schmitt**

Chicago: The month of May on Chicago's Midway featured a doubleheader program for our Section. The gaily decorated Fifth Army Officers' Club provided a scenic setting for the annual Spacetronautic Banquet on May 16th, which included rocketeers, environmental scientists, and their ladies. A social hour, under the auspices of industrial sponsors, preceded the banquet. Guest speaker for this event was **John P. Marbarger,** director of the Univ. of Illinois Aeromedical Laboratory, who presented an enthusiastic and entertaining description of "Biology and Medicine in Space Exploration."

Then, the following officers for the 1961–1962 season were installed by incoming Section director Milt Goldstein—C. C. Miesse, president; A. A. Fejer (Chairman of IIT's ME Dept.), vice-president; R. C. Warder, secretary; and E. Terner, treasurer.

The "twilight game" of the May double-header featured a technical address by Battelle Memorial Institute's **Robert E. Maringer.** Addressing a group of engineers, chemists, and members-at-large, assembled in the Chemistry Conference Room of the Armour Research Foundation, Maringer discussed "Meteorites and Their Past Environment."

Additional Maytime activity included co-sponsorship of the National Telemetry Conference, for which Milt Goldstein served ably as hospitality chairman.

—**C. C. Miesse**

Detroit: The following members are our 1961 officers: James S. Kirk-

Zarem Maps Plan to Double ARS Membership by Nov. 1

A.M. Zarem, ARS Membership Committee Chairman, has announced a bold plan to double ARS membership during the next two months as the first step toward achieving the aims expressed in the Editorial on page 21.

"While this goal may appear unrealistic," Dr. Zarem comments, "it is by no means impossible of achievement, especially if we realize that all it would require is that every present ARS member get just *one* new member during this two-month period. The strength and prestige of the Society will be immeasurably enhanced if we can achieve this goal."

Each ARS member who gets a new member during the months of September and October will receive free one of the new ARS membership pins, using a new ARS symbol to be introduced at the SPACE FLIGHT REPORT TO THE NATION in New York next month, Dr. Zarem added.

A mailing is now going out to all ARS members which contains complete details on how to qualify for the free membership pins.

patrick, president; Benjamin W. Badenoch, vice-president; Lovell Lawrence, secretary; and Charles W. Brownell, treasurer.

Holloman: At the June dinner meeting, held at the Officers' Club of Holloman AFB, Section President **Harald J. von Beckh** introduced the head table, which included **Knox Millsaps** and other prominent guests from the Holloman Summer Scientific Seminar in Astrophysics at Cloudcroft, N.M.

Dr. Millsaps introduced the speaker of the evening, **Gerard P. Kuiper,** Director of the Lunar and Planetary Observatory, Univ. of Arizona, who discussed the earth as a planet seen by a traveler returning from outer space. The talk touched on the following subjects: origin of earth and moon, composition and origin of the atmosphere, temperatures (ice ages, etc.), earthquakes, continents, changes in earth rotational period, and migration of the poles and the continents. These subjects, illustrated with many good slides, were covered in such a manner that the entire group, both technical people and laymen, found them interesting and enjoyable.

—Robert C. Whipple

Kansas City: Twenty-four members of the Section shared a chuckwagon dinner at the World War II Memorial Building in April, and heard **James G. Gaume,** Chief of Space Medicine for Martin-Denver, talk on "Biological Problems in Space Operations." Dr. Gaume reported, among other things, a new insight into the influence gravity exerts upon man's metabolism and activity at the earth's surface, as well as some of the measures designed to offset the lack of a gravity force during space flights. A vigorous and lengthy questioning period followed his unusual talk.

The Section presented its annual plaque award to **Paul Hoyt,** a student of Shawnee Mission-North High School, Mission, Kan., for his local science fair exhibit on an inertial guidance system. The Section also awarded certificates of merit to 10 other exhibitors at the science fair.

In May, 21 members and guests toured Midwest Research Institute's Deramus Field Station, which is located at Grandview, Mo. Following the tour and a sumptuous barbecued-beef picnic, the Section heard from guest speaker, Capt. **Ronald Weinsaft,** Information Officer, Shawnee-Mission (Kansas) Squadron, Civil Air Patrol. Capt. Weinsaft formally requested the Kansas City Section to provide a full staff to teach a space-age course designed for CAP cadets. Seven Section members—Verne Davis, Hank Pollock, Fred Bergman, Dick Fetter, Jim Downs, Bob Stapp, and Frank Inderwiesen—did teach the course, which began June 19th and ended July 17th with written exams.

—H. B. Pollock

Maryland: The Section's award to the outstanding engineer in Maryland went this year to Warren W. Berning of the Ballistic Research Laboratory, Aberdeen Proving Ground, for his outstanding work in ballistic research. The award was presented by ARS Executive Secretary **James Harford** at a dinner meeting held in May at the Westinghouse Air Arm plant.

Incidental information—The Maryland Section has been accepted as an affiliate member of the Engineers Club of Baltimore.

Education—Registration for the Space Institute held this year on the Baltimore Campus of the Univ. of Maryland totaled 400. The meetings were highly successful. Over 300 persons received the Univ. of Maryland Workshop Diploma for successfully completing the lecture series.

Membership—Membership in the Section increased by nearly 20% during the past year, and now totals approximately 350. This places the Section in the upper third nationally.

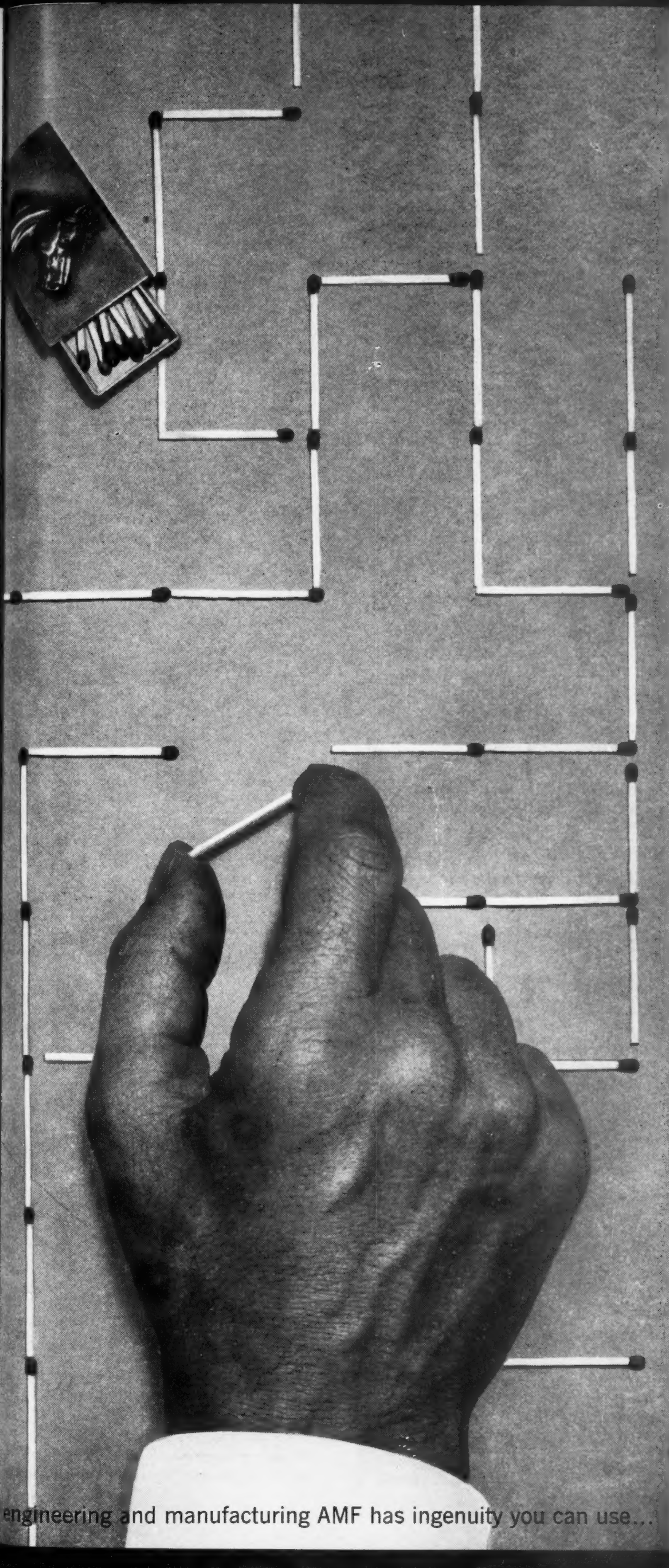
Officers—The following officers have been elected for the coming year: Joseph H. Glifford, Westinghouse Air Arm, president; Robert W. Scarborough, Martin Co., vice-president; Richard J. Pinamonti, Aberdeen Proving Grounds, secretary; and Theodore G. Stastny, Aircraft Armaments, treasurer.

At a June meeting, guest **Albert W. Hetherington,** ARDC Technical Director for Bioastronautics, discussed "Life Support and Medical Aspects of Man-In-Space." Dr. Hetherington covered the biological problems confronting man as he attempts to enter the environments of outer space. He discussed present experiments for exploring weightlessness, human reaction time while traveling at high orbital speeds, effects of radiation, and mental strain.

Dr. Hetherington's talk was the final topic in our Man-In-Space Lecture Series for the 1960–61 season. The meeting was held at the Westinghouse Air Arm Div. in Baltimore following a cocktail hour and dinner.

—Howard C. Filbert

National Capital: At a luncheon meeting held at the Washington Hotel in June, the Section heard **Leo Steg,** manager of GE's Space Sciences Laboratories, discuss "Man vs. Ma-



He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

Single Command Concept

AMF's imagination and skills are organized in a *single operational unit* offering a wide range of engineering and production capabilities. Its purpose: to accept assignments at any stage from concept through development, production, and service training...and to complete them faster...in

- *Ground Support Equipment*
- *Weapon Systems*
- *Undersea Warfare*
- *Radar*
- *Automatic Handling & Processing*
- *Range Instrumentation*
- *Space Environment Equipment*
- *Nuclear Research & Development*

GOVERNMENT PRODUCTS GROUP,
AMF Building, 261 Madison Avenue,
New York 16, N. Y.

AMERICAN MACHINE & FOUNDRY COMPANY

chines for Space Exploration." The luncheon meeting was well attended.

—E. Paul Jackson

Northeastern New York: Newly elected officers of the Section are as follows: Erwin Fried, president; Howard H. Fawcett, vice-president; Augustus H. Fox, secretary; and Alfred R. Graham, treasurer. These officers will serve from June 1961 through May 1962.

—Erwin Fried

Northern California: Members and guests attending the May dinner meeting at L'Omelette restaurant in Palo Alto witnessed installation proceedings and presentation of a charter to the newly formed Stanford Univ. Student Chapter. Student officers—president, Peter Zimmerman; vice-president, Michael Randall; secretary, Henry Werner; and treasurer Bill Feyer—were introduced by their faculty sponsor, **Howard Seifert.** Dr. Seifert, in his capacity as member of the National Board of ARS, presented the charter to Zimmerman.

Then, guest speaker **Albert Shapero,** manager of the systems-analysis program in the Economics Div. of Stanford Research Institute, presented the feature address of the evening on "Men, Missiles and Malfunctions," describing his work on methods and models for the analysis of man–machine systems. Shapero made the following points:

1. A significant portion of recorded malfunctions are human-initiated (20 to 53% of reported equipment failures and 16 to 23% of unscheduled holds).
2. The malfunction-data-collection systems being used are inadequate for identifying or obtaining pertinent data on human-initiated malfunctions.
3. Little, if any, systematic human-factors performance testing is being undertaken.

And he remarked, "Designing humans out is not the answer as humans make the lousy designs work!" He concludes that to attack these problems we need systematic approaches which will enable them to be handled within the current engineering context.

—Robert O. Webster

Orlando: The following are the officers elected for the 1961–62 season: Edward T. Munnell, president; Raymond T. Patterson, vice-president; Joy L. Floyd, secretary; and Robert J. Classen, treasurer.

—John M. Allen

Pacific Northwest: The first meeting of 1961 was held in March at the Boeing Scientific Research Laboratories, with 68 attending, including students from the local universities. Guest speaker **Robert J. Parks,** JPL's Planetary Programs Director, discussed the unmanned lunar and planetary exploration programs of NASA, including details of Ranger, Surveyor, Prospector, Mariner, and Voyager. Of particular interest was the wealth of data basic to the flight planning of such missions.

The second meeting was held in May, also at Boeing SRL, with 45 members and guests, including students, attending. Guest speaker **Eugene Perchonok,** manager of the Advanced Engines Research Dept. of Marquardt's Astro Div., discussed "Hypersonic Air Breathing Orbital Boosters."

His estimates of the commitments to space included about 25,000 tons to a lunar base at a cost of about 15-billion dollars. A manned space station was estimated at aggregate 6400 tons for a cost of 5 billion. With such

Air Force Officers to Hold Symposium at SFRN

An Aerospace Symposium will be held by the N.Y. Air Reserve Procurement Section Headquarters of the Eastern Contract Management Region for 250 reserve officers on Saturday, Oct. 14, at the N.Y. Coliseum, Lt. Col. Max Kaplan, program chairman for the symposium has announced.

The symposium, which will be held during the ARS SPACE FLIGHT REPORT TO THE NATION, will review the military and commercial aspects of the aerospace industry. The symposium will be conducted during a single morning session and in the afternoon the officers will be given a guided tour of the exhibits at the annual ARS Astronautical Exposition.

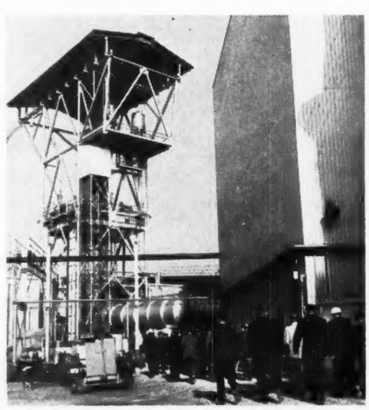
Participants in the symposium will be James R. Kerr, president, Avco Corp.; Gen. Walter Bain, vice president, RCA; Arthur Kantrowitz, chief scientist and vice president, Avco Corp.; and Willy Ley, noted lecturer and author in the field of astronautics.

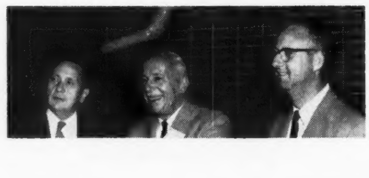
An estimated 250 air procurement reserve officers from New York, Philadelphia, Boston, Middletown, Pa., and Dayton, Ohio are expected to attend. Members of the 9215th Information Services Squadron, including Robert Wagner, Mayor of New York City, who is a member of the squadron, have also been invited to attend the symposium.

ARS Tennessee Section Participates in Simulated-Altitude Rocket Testing Symposium

More than 200 rocket experts from industry, government, the military, and research and educational institutions attended a two-day symposium recently on simulated-altitude testing of rocket motors at the Arnold Engineering Development Center, Arnold AFS, Tenn. The ARS Tennessee Section, many of whom are members of ARO, Inc., contractor company for AEDC operations, provided support for the meeting.

Above right, visitors enter Satellite Rocket Cell J-3 on a tour of the AEDC facilities. Below right, Walter Dornberger, center, vice-president and chief scientist of Bell Aerosystems Co., prepares to speak on the military uses of space at a banquet during the symposium. He is flanked on the left by B. H. Goethert, director of engineering for ARO, and on the right by C. T. Morrow, manager of technical relations for Aerospace Corp., a sponsor of the symposium.





high costs, his view was that some form of propulsion other than rockets should be used for the first stage to achieve much higher specific impulses. Suggested were supersonic-ramjet and hybrid ramjet-rocket engines combined into a recoverable system. His discussion produced a lively question and answer period, unfortunately cut short by the then late evening hour.

Section President Beckelman announced that **Eugen Sanger** has tentatively accepted an October, and the Hon. **Henry M. Jackson,** U.S. Senator from Washington State a November, speaker's role.

—**Howard C. Tinney**

Palm Beach: In June, some 57 members and guests heard guest speaker **Dorian Shainin,** vice-president of Rath & Strong of Boston, Mass., discuss "Reliability in Aerospace Technology." This meeting and talk were certainly one of the highlights of the year. The discussion started with basic reliability definitions and led into an analysis of the techniques which are being used to demonstrate reliability. Of special interest were some of the latest methods being used to demonstrate reliability with a fewer number of test specimens.

The Section experienced its best-attended meeting to date in June, with 170 members and guests present. The speaker was NASA's **Jack Abercrombie,** chief, Saturn project, Cape Canaveral, who discussed the Saturn Project, in particular the launch pad at Canaveral. He also presented the latest Mercury project progress-report film.

—**Harold J. Tiedemann**

Tennessee: Approximately 120 members and guests attended the May meeting of the Section to hear Maj. Gen. **Don R. Ostrander,** director of Launch Vehicle Programs for NASA, discuss current and future boosters for the nation's space program. He discussed various configurations and proposals for Saturn; Apollo and Nova and their proposed use; nuclear power for space craft; and orbiting space-stations as stepping stones for flights to Mars and Venus. His presentation was concluded with a short NASA film concerning Commander Shepard's suborbital space flight, including previously unreleased films taken of Commander Shepard during his flight. This was a most entertaining and informative evening.

Members of the Section and of the Univ. of Tennessee Student Section provided support for the Simulated-High-Altitude Rocket Testing Symposium held at the Arnold Engineering Development Center June 28–29. More than 200 top-level specialists in

the rocket, missile, and space-vehicle fields attended the technical presentations and panel discussions, in which current and future testing-facility requirements were reviewed.

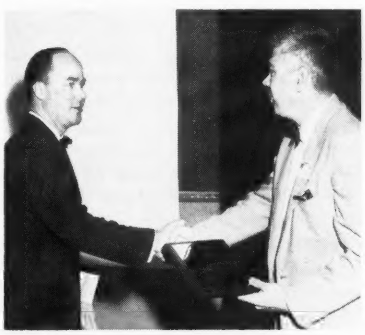
The technical papers presented, with few exceptions, reflected the testing techniques utilized to investigate liquid and solid-system performance parameters in a high-altitude condition. Seven of the 26 papers dealt with facility requirements for testing at high altitude and space simulation techniques for improving future testing.

The symposium concluded by predicting what the test requirements will be for future weapon systems.

Walter Dornberger, the main banquet speaker, gave his views on what part the military should play in the space program.

—**T. J. Gillard** and **Harvey M. Cook**

ARS Maryland Section Honors W. Berning

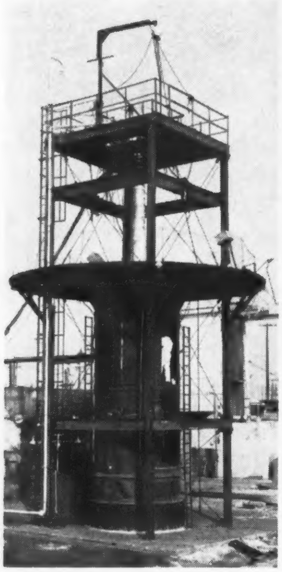


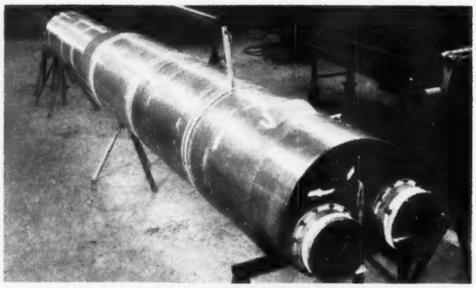
Warren Berning, right, receives the ARS Maryland Section's annual award for contributions to rocketry and astronautics from James Harford, ARS National Executive Secretary, at ceremonies during a special dinner meeting held recently at Westinghouse Air Arm Div. On the staff of Aberdeen Proving Ground's Ballistic Research Lab, Berning received the award in particular for his outstanding contributions to ballistic research.

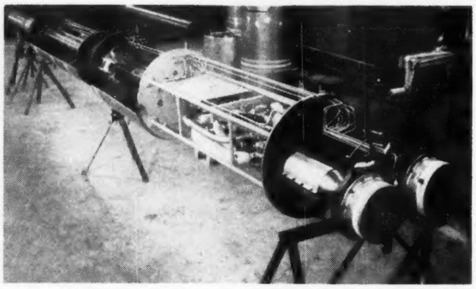
DSIF Adding S-band

The Seigler Corp. has received a $500,000 contract from JPL to design and build S-band (2300-mc) equipment for the Goldstone DSS of the NASA Deep Space Instrumentation Facility. Eventually Woomera and Johannesburg DSS's will receive similar equipment. S-band will figure in communications for many deep-space and lunar vehicles.

Simulator Paves the Way for Successful Titan Silo Launch







This small-scale Aerojet facility evaluated Titan silo-launching design. A model Titan can be seen protruding above the deck disk in left photo, and at the right it is seen with and without its external skin.

The successful launching of a Titan missile from a silo at Vandenberg AFB in early summer culminated over two years of research and testing at Aerojet-General to establish design criteria for construction of operational underground launching silos. The scale-model silo shown (left) and the miniature Titan missile pictured on the right were built and tested at Aerojet's Azusa plant for this work.

The ground level of the operational silo was simulated by a 30-ft-diam steel platform midway up the tower. The scale-model Titan, shown projecting above the platform in the photo (left), was fired from a 4.5-ft-diam duct fitted inside the main silo cylinder. The scale model was powered by two Aerojet-produced Nike-Ajax liquid engines. The photos right show this test vehicle with and without its external skin.

Operational Titan missile silos will be 139 ft long—about the height of a 14-story building—50 ft wide and completely underground.

DSIF in Ranger Project

(CONTINUED FROM PAGE 37)

doppler and to a standard reference frequency in the case of one-way doppler. In the one-way system, where the spacecraft generates and transmits a carrier signal to Earth, the drift in frequency of the spacecraft oscillator is unknown. Consequently, the received frequency will not reflect the true doppler shift.

In the two-way system, any drift of the transmitter-oscillator can be measured precisely, and the doppler measurement can be adjusted accordingly. Also, in the two-way system, the doppler-frequency shift is approximately doubled, since the carrier signal must travel to the space vehicle and back again. Therefore, the precision with which the radial velocity can be measured is increased, inasmuch as a specific velocity is represented by a larger frequency shift than in the one-way system. The doppler frequency shift is measured in the DSIF at nominally 30 mc, except at the Goldstone Station, where, for greater precision, the frequency is multiplied by 30 to obtain the shift at the carrier frequency.

During those periods when the space probe is "visible" to both the Goldstone Station and an overseas station, the signal received by the overseas station will be the Goldstone carrier as retransmitted by the space-probe transponder. The data so received by the overseas station may then be correlated with Goldstone transmission data and a pseudo two-way doppler measurement achieved. Similarly, the accuracy of the one-way system may be improved whenever the space vehicle is "visible" to both overseas stations. By correlating the recorded data from each station, the spacecraft-oscillator drift may be calculated and the data measurements improved.

Interim Configuration Used

The nominal system parameters for the Ranger 1 and 2 experiments represent an interim configuration which will be updated for Ranger 3, 4, and 5. Under the present design, the DSIF has a measured antenna gain of 44 db, a system excess noise temperature of 1430 K, and a transmitter power capability of 200 watts. The Ranger 1 and 2 space vehicles will have antenna gains of nominally 18 db for the directional antenna and 0 db for the omnidirectional antenna. The spacecraft receiver has an excess noise temperature of 5800 K, with a transponder-transmitter power output of approximately 3 watts. The graphs on page 37 show typical spacecraft-to-Earth and Earth-to-spacecraft communication capabilities for Ranger 1 and 2.

Scientific and engineering measurements taken by instruments on the Ranger 1 and 2 space vehicles are transmitted to Earth by normal telemetering techniques. Telemetry data are received in the form of a carrier frequency which is phase-modulated by a number of audiofrequency subcarriers (channels). Nine telemetry channels are available within a bandwidth of 3.5 kc. Subcarrier detection is accomplished by means of a bandpass filter and discriminator for each subcarrier channel. The subcarriers are frequency-modulated with either analog voltages or binary data, depending upon the type of measurements involved. Also, in order to increase the number of measurements which can be transmitted from the space vehicle, the measurements are time-multiplexed on the subcarriers; that is, two or more measurements will alternately modulate a subcarrier at specific intervals and for specific lengths of time.

Since time is one of the basic parameters of scientific measurement, the precision and accuracy of measurements depend upon the timing techniques used. The DSIF employs a temperature-controlled crystal oscillator to produce a 1-mc/s signal, which is used as the basic timing frequency for the system. Accuracy is maintained by comparing the DSIF timing signal with the international timing signal from station WWV.

Also, in addition to providing time labels, the timing system provides reference frequencies for extracting information both from incoming spacecraft signals and from the monitoring signals of the DSIF equipment. The information extracted from these signals is conditioned and then recorded by seven-channel magnetic-tape recorders and/or direct-writing oscillographs.

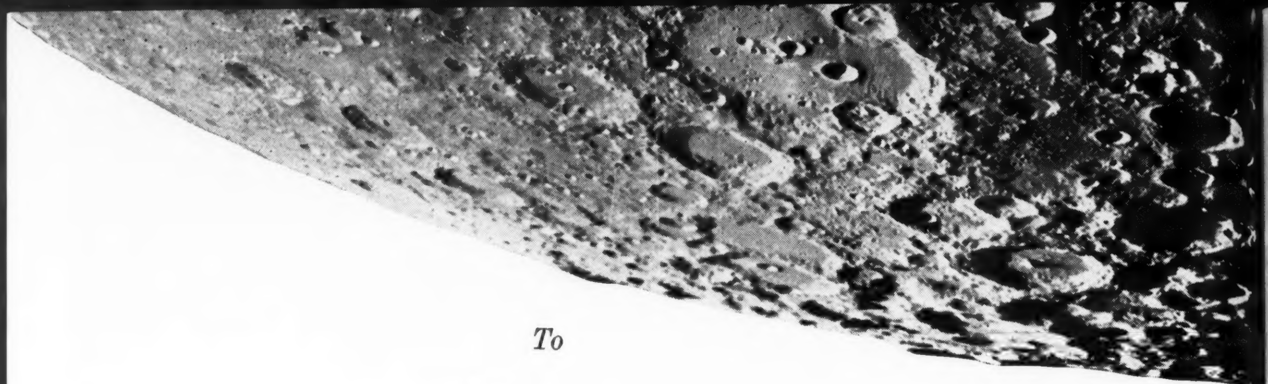
For the hard-lander series—Ranger 3, 4, and 5—the DSIF capability will be expanded in several areas. A 10-kw 890-mc/s transmitter will be installed at the Johannesburg Station in time for Ranger 4 and will enable the station to have complete transmit-receive capability. This transmitter however, will be used in a 200-watt mode for this program. Parametric amplifiers will be installed at each site, reducing the standard receiving-system noise temperature from a nominal 1430 K to 220 K. A maser amplifier will be provided at the Goldstone Station to enable RF tracking through the retro-maneuver and to provide other low-noise listening when required. System noise temperature with this maser will be a nominal 75 K (not including the contribution of the Moon at 960 mc/s, which adds approximately 30 K). Improved listening feeds will be installed concurrently with the installation of the low-noise amplifiers. The lower noise temperature for the receiver system will improve the spacecraft-Earth signal-to-threshold ratio approximately 8 db. The DSIF will track each successful hard-landed vehicle for a period of 90 days or as long as the 33-milliwatt lunar transmitter is operating. The expected signal-to-noise ratio of the seismometer data in a 5-cps bandwidth will approach 20 db.

Acknowledgment

The author acknowledges the invaluable assistance of B. Ostermier and J. R. Hall of JPL and R. Van Buren of Tridea Electronics Co. in the preparation of this paper. ♦♦

Welded Rocket Motor Case Fabrication Booklet Offered

The American Welding Society has just published a 65-page booklet on "Fabrication of Welded Rocket Motor Cases," prepared by the AWS Missiles and Rockets Welded Fabrication Committee. Covering materials, design, welding, and quality assurance, the booklet is available to ARS members at the special price of $2. Copies may be obtained directly from the American Welding Society, 33 W. 39th St., N.Y. 18, N.Y.



The Ranger Booster

(CONTINUED FROM PAGE 31)

programmed autopilot. After about $2^1/_2$ min, the booster engines are stopped and jettisoned, and guidance control is transferred to the G.E. radio guidance unit. The Agena restart timer, which activates the primary Agena timer to set the time of lunar injection from the parking orbit, is started by ground command through the Atlas guidance system. After the sustainer engine is stopped and the Atlas is controlled and propelled by the vernier engines, the primary Agena timer is started by Atlas guidance from ground command. The Atlas vernier engines are then stopped, the Agena inertial reference package is uncaged, the shroud over the payload is ejected, the Agena is separated from the Atlas, the Agena control system is activated, and the first coast phase begins. During this coast phase, the Agena attitude is changed to nearly horizontal, and the horizon sensor is activated.

The guidance system of the Agena consists of the horizon sensor, inertial

Initial Orbital Parameters of Discoverer Satellites

Discoverer number	Injection altitude (nautical miles)	Injection angle (degrees)	Eccentricity (actual)
1	159	−2.5	0.059
2	138	+0.2	0.007
3	144	−0.22	Orbit not achieved—velocity low
4	90	+0.1	
5	120	+0.01	0.041
6	121	+0.4	0.047
7	114	−0.34	0.049
8	114	−0.04	0.102
9	Orbit not achieved—booster malfunction		
10			
11	92	−0.16	0.32
12	90.5	−8.3	Orbit not achieved—Agena failure
13	139.7	+0.18	0.0326
14	104.6	−0.22	0.046
15	114.2	−0.1	0.040
16	Agena failure—no injection		
17	103.4	−0.14	0.0582
18	136.0	−0.02	0.031
19	117.7	−0.5	0.0334
20	177	+0.3	0.0366
21	112.1	−0.14	0.0372
22	Agena failure—no orbit		
23	165	−0.03	0.026
24	Agena failure—no orbit		
25	Orbit and recovered successfully		Parameters not available at time of writing

reference, velocity meter, primary timer, restart timer, junction boxes and resistive networks. The horizon sensor provides the local vertical in pitch and roll.

The stabilization system which enables the Agena to maintain its position relative to the local vertical depends primarily upon attitude information supplied by three orthogonal position gyros in the inertial reference package. The position signals from this package, combined in conventional manner with rate information, are used to control the vehicle attitude through two alternative control systems. When the vehicle is coasting (during ascent or on orbit), the error signals actuate cold gas reaction jets through specially designed proportional gas valves. The jets are fed by a mixture of dry nitrogen (N_2) and tetrafluoromethane (CF_4) stored at high pressure in a titanium sphere. The pitch and yaw moments provided by this control system, although adequate for coasting flight, are not designed to overcome the asymmetry of the main rocket motor during powered flight. They are therefore locked out when the main motor is operating, and pitch and yaw control is then obtained by two hydraulic servos moving the main engine nozzle.

The method used to guide the Agena vehicle into orbit, and its subsequent operations during orbit, require the orientation of the vehicle to be changed by command from the timer. These maneuvers are achieved by torquing the position gyros of the inertial reference package in response to electrical command signals.

This steady rate is only a rough approximation to the accurate pitch rate. To provide accurate location relative to the local vertical in pitch, and also to compensate for the drift in all three gyros of the inertial reference package, a continuous indication of the local vertical is provided by the horizon sensor. The sensor measures directly deviations from the required attitude in pitch and roll, and its error signals are applied to correct the positions of the pitch and roll gyros in the inertial reference package. The roll error signal from the horizon sensor is also fed to the yaw gyro, operating in a "gyro-compassing" mode to correct any deviation in yaw.

In this system, a drift rate of the position gyros, or an inaccuracy in the pitch rate pre-programmed to take account of the orbital motion, will result in an offset in pitch, roll, or yaw, depending upon the gain of the horizon scanner coupling.

The timers are digital counters which are pre-set before launch to supply an activation signal to all

Agena equipment that must be started and stopped at a precise time during the sequence of events of a trajectory. The time of starting the primary timer is controlled by ground command through Atlas guidance. The time for stopping the first Agena burn is controlled by the velocity meter. The time of ignition for second burn is controlled by the restart timer, and the time of engine-off is controlled by the velocity meter.

The spaceframe is built of magnesium-thorium alloys. This subsystem is the frame or the platform from which the other subsystems perform their functions. It includes a shroud to protect the payload from dynamic pressures and aerodynamic heating in ascent, a forward equipment rack, integral fuel tanks made of 6061-T6 aluminum with hemispherical bulkheads, aft midbody assembly which provides the interface for the separation plane between the Agena and the booster adapter, and aft equipment rack which encloses the engine and provides space for the attachment of standard or special equipment, e.g., pressurization spheres, hydraulic system, and gas jets.

Engine Is Hustler Type

The engine is manufactured by Bell Aircraft Co. and is a variation of the Hustler engine. The fuel is UDMH, and the oxidizer IRFNA, a hypergolic combination. The engine system consists of the thrust chamber, turbine pump, and engine mounts. The two turbine pumps supply the propellants at the required flow rate and pressure. Solid-propellant starters are used which provide hot gas to a gas generator which drives a turbine connected to the pumps. The gas generator is then powered by UDMH and IRFNA for the remainder of its operation. The pump assembly also powers the hydraulic pump. The engine is gimballed and uses hydraulic actuators. Part of the total thrust of the engine is supplied by the exhaust gases of the gas generator.

Electrical power for the Agena is supplied by silver-peroxide-zinc batteries. Inverters, a power amplifier, regulator switches, and filament transformers are used to convert, boost, regulate, and distribute the electrical power.

At the end of the coast phase, which is at an altitude of 100 n.mi., the solid-propellant ullage rockets are fired. The acceleration of these rockets provides a net positive pressure head for the propellants to the pump, the engine is started, and the Agena achieves the required velocity for a 100-n.mi. circular parking orbit. After the end of first burn, the Agena

coasts through the distance subtended by an angle of about 50 deg. Then the second set of ullage rockets is fired, and second burn begins for the lunar injection trajectory. At the end of second burn, the payload is separated, the Agena is turned through an angle of 180 deg in yaw, and a third set of ullage rockets is fired to change the Agena trajectory so that it will not hit and contaminate the Moon. The payload proceeds on the lunar trajectory and corrections are applied by ground command. Lockheed also developed the sterilization equipment that is used to sterilize the payload before launch.

The guidance and control system has demonstrated a high degree of precision in previous Agena flights, and the following review of the requirements and performance will show this capability. At this time, the greatest part of the Agena experience has been obtained on the AF Discoverer Program, so it will be used to describe the importance of achieving precise control of injection velocity and flight path angle.

The allowable error in velocity and flight path angle to achieve and stay in orbit decreases as the injection altitude decreases. A slight inclination, or a small deficit in velocity, will cause a portion of the orbit to be so low that the atmospheric drag will de-orbit the vehicle. The graph on page 30 shows the error in velocity and angle which will de-orbit a Discoverer vehicle after one orbit if the planned orbit were circular. At the altitude of 104 n.mi., or 120 (st.mi.,) typical of the present Discoverer injection condition, an angle error of ±1.1 deg or a velocity deficit of only 100 fps below the value for a circular orbit will result in failure to complete the first orbit.

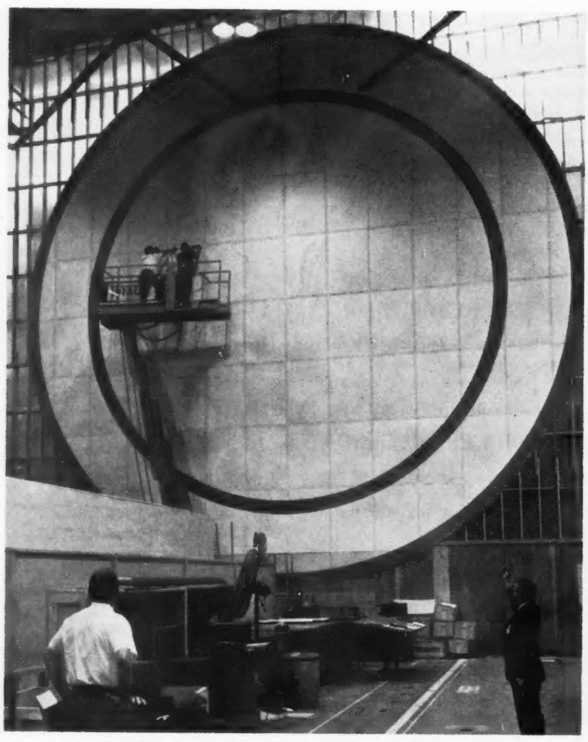
The table on page 73 presents a summary of the injection angles and orbit eccentricities achieved with Discoverer. The orbit eccentricity is the ratio of the difference of the apogee and perigee altitudes measured from the center of the Earth to the sum of the altitudes. As can be seen from the table, the Agena guidance system is able to control the flight path angle at injection to a much smaller error than this limit. The error of $2^1/_2$ deg in Discoverer I resulted from a decision to utilize only the inertial reference package, and not the horizon scanner, during the thrust phase. Fortunately, the first Discoverer was launched at much higher altitude than now employed, so that the effect of this error was merely to increase the eccentricity to 0.059. All subsequent Discoverers have had the horizon scanner coupled into the guidance circuit throughout the ascent phases, and the error in injection angle has then not exceeded 0.4 deg, except for Discoverer XII which did not achieve orbit. With this excellent performance, injection-angle error has had negligible effect upon the resulting orbit.

Successes and Failures

The failure of Discoverers III and IV to achieve orbit is directly attributable to inadequate injection velocity. At that time, data available on probable deviations in a number of critical parameters was sketchy. For example, the deviations in altitude performance of the engine and fuel system were not appreciated. The success of Discoverer II, which attained an orbit more circular than the Earth over which it was travelling, led naturally to a decision to base the performance of the more heavily loaded Discoverers III and IV, at lower altitudes, upon the same parameters. Their failure to orbit resulted in a complete examination of component performance margins and the establishment of suitable limits. As can be seen from the table, subsequent Discoverers have achieved orbit with an adequate margin.

The velocity meter used on the Ranger is more accurate than the one for Discoverer. Therefore, the accuracy of injection into the parking orbit with a Ranger is better than with a Discoverer. This additional accuracy is required because of the long coast time between first and second burn and the accuracy required for lunar injection. ♦♦

Toward a Nova Vehicle



Left, NASA Marshall Space Flight Center Fabrication Div. constructed this 43-ft-diam disk in effort to get a line on Nova vehicle first-stage fabrication problems. The disk, about twice the diam of Saturn first stage, indicates Nova engines will be attached to thrust frame similar to that used on Saturn. Right, one Nova vehicle concept, described in address by Wernher von Braun, Marshall Director, last month. The four-stage vehicle would be 400 ft high, weigh nearly 10 million lb. First stage would use eight F-1 engines with total thrust of 12 million lb; second stage, eight lox-hydrogen engines with thrust of 1.6 million lb; third stage, two lox-hydrogen engines; and fourth stage would be either a modified Saturn stage or a stage using a storable propellant. Apollo capsule sits atop the vehicle.

Ranger Lunar Capsule

(CONTINUED FROM PAGE 33)

has reached the proper distance from the Moon, it signals for the separation of the landing capsule from the bus. This signal explodes bolts which are holding a Marman-type clamp between the retrorocket and a bus-mounted support structure.

After separation, the bus goes on to impact on the lunar surface at full velocity. Meanwhile, following separation, the landing capsule is spin-stabilized by three symmetrically placed torque nozzles fed by a single gas generator. As shown in the photo on page 33, this unit is mounted in the exit of the retrorocket nozzle, with the torque jets outside the periphery. Ignition of the retrorocket automatically jettisons the spin assembly.

The retrorocket is being developed for Aeronutronic by Hercules Powder Co. In addition to tests by the manufacturer, its flight-acceptance testing includes firings in the elaborate environmental facilities of Air Force's Arnold Engineering Development Center. These latter tests carefully measure the retrorocket's performance and determine the effects of storage upon the propellant. The way in which the retrorocket is used places unusual emphasis on the reproducibility of its impulse and burning time, because errors in these result in increased energy of impact.

The function of the retrorocket is to remove about 8800 fps of terminal velocity, permitting the capsule to impact with a residual velocity no greater than would result from a 500-ft fall on Earth or a 1000-ft free-fall in the Moon's lesser gravity field. Upon burnout, and just before landing, the retrorocket case is also jettisoned from the landing sphere.

Falls to Lunar Surface

Braked by the retrorocket, the landing sphere falls to the lunar surface. It contains the impact limiter and the fluid-floated survival sphere with its all-important instrumentation.

The thick, ball-shaped impact limiter is made of balsa wood, manufactured from a large number of carefully cut sections assembled so that the grain of the wood radiates outward in all directions from the hollow center, as shown in the photo on page 33. Exhaustive tests on the special sphere-acceleration device in the Environmental Test Laboratory of Aeronutronic, as well as a series of free-falls from aircraft have proved this omnidirectional impact absorber capable of dissipating more than 20,000 lb of kinetic energy per pound

of acting material—a figure about three times better than that provided by more-conventional impact-limiting materials and structures. The sphere crushes but remains integral after absorbing the impact as shown by the photo on page 33.

After the landing capsule comes to rest on the Moon, the survival sphere within it erects. As mentioned, this is an automatic occurrence, because the unit is fluid-floated within the impact limiter and its center of gravity is slightly below the center of the spherical cavity. Erection automatically aligns the sensitive axis of the seismometer and the directional antenna along the local lunar vertical. The entire survival sphere is caged by squib-actuated devices, and then explosive penetrators pierce the impact limiter to allow the Moon's vacuum to exhaust the flotation fluid. The seismometer is uncaged by the removal of the fluid, which is also used to hold the seismometer pendulum fixed during impact.

The timing, control, and ignition system continues the sequence of events by activating the seismometer and telemetry units. Internal temperature is controlled by an advanced form of insulation, similar to that used in storing liquid hydrogen, and a distilled-water boil-off system. The pressure on the water is regulated so that it boils at ordinary room temperature during the lunar day. At night, the water keeps the temperature above 32 F by partially freezing if necessary.

Scientific data generated by the seismometer are relayed back to receiving stations on Earth by the lunar capsule's telemetry system. Batteries, made especially for Aeronutronic by Electric Storage Battery Co., supply the necessary power. The seismometer is direct-coupled to an Aeronutronic-developed preamplifier that has excellent thermal-drift characteristics as well as high gain. The inherent noise level of this amplifier is about a factor of 10 lower than any similar device known to have been developed previously. Thus, the microseismic noise levels that can be detected are far lower than those observed in the quietest locations on Earth.

Data Handling and Transmission

The output amplifier processes the data which cover a wide band of very low frequencies and amplitudes (for quakes, this may be 1 million or more times the microseismic noise level) into a form more suited to the telemetry link. The data in direct analog form are used to frequency-modulate the transmitters. The transmitter is a crystal-controlled, all-transistorized instrument. The lunar-capsule antenna provides a broad radiation beam, which will include the Earth, even though the vertical axis of the antenna can be as much as 45 deg away from

Lunar Capsule Weight Summary

		Weight (lb)
(1)	Retrorocket Payload	
	Survival sphere	
	Electronics, antenna, batteries and wiring	24.24
	Structure, insulation, devices	13.32
	Water	3.71
	Seismometer (filled with 1.0 sp gr fluid)	7.80
	Flotation fluid and outer shell	5.99
	Survival sphere total	55.06
	Impact limiter	
	Cover, wood, inner shell, and rocket motor/sphere and omni interconnects	34.79
	Vibration damper	0.40
	Control timer, batteries, wiring	1.35
	Total retrorocket payload	91.60
(2)	Motors	
	Retrorocket motor and igniter	195.9
	Spin motor, igniter and attachment	2.2
	Total separated weight	289.7
(3)	Bus mounted equipment	
	Altimeter and antenna	5.5
	Altimeter support and deployment	1.5
	Motor support structure and separation	3.0
	Bus interface J-Box and connectors	0.3
	Total Lunar Capsule	300.00

the Earth-Moon line, because of the choice of landing site and the oscillations of the Moon's orientation with respect to the Earth. About $^1/_{20}$ watt of RF power is radiated toward Earth.

For the protection of archeological data, as well as to minimize the danger of destructive infection, it is a requirement on all unmanned space exploration that the complete spacecraft be biologically sterile.

Later lunar landings, of course, will have to include bioastronautic experiments in support of eventual manned expeditions, which may change the sterilization requirements. Meanwhile, the technology of sterilization must be well developed before unmanned equipment can be intruded into the planets. The lunar missions are the proper starting points for the development of this technology. In this regard, Aeronutronic is pursuing an extensive program, seeking sterilization techniques appropriate to the development and manufacture of the lunar capsule in particular and spacecraft in general.

Everything in the lunar capsule—the balsa wood of the impact limiter and even the components of batteries—is being made completely sterile, down into the interior of all solid substances. Some items can tolerate baking at high temperatures and long durations necessary to guarantee sterilization; but some must be specially treated to obtain an internally sterile component, and then must be installed into a baked assembly, using a sterile glove box that contains surface-sterilizing gas. Many desirable components still have to be excluded from the design, because they cannot be sterilized or manufactured so as to assure sterility. Developments that have aided in this area include the discovery of self-sterilizing laminating agents and potting compounds. Another sterilizing means, ionizing radiation, has not proved very attractive, because it damages many of the components that are damaged by heating.

Component by component, assembly by assembly, subsystem by subsystem, and finally as a complete entity, the lunar capsule requires extraordinarily exhaustive proof testing. Much of this is accomplished in the Environmental Test Laboratories of Aeronutronic, although some important tests are conducted at other institutions, such as the Jet Propulsion Laboratory, the California Institute of Technology's Seismological Laboratory, or Arnold Engineering Development Center.

In order to be sure that the laboratory tests are truly representative of flight conditions, the entire system in flight configuration is also subjected to simulated-lunar-landing tests. Complete capsule systems are dropped

from aircraft at appropriate altitudes, velocities, and angles of approach. The capsules impact upon a variety of terrain—ranging from dry lake beds to rock piles—representing some of the extreme but possible types of lunar surfaces. The photo on page 33 shows a capsule after drop onto a dry-lake bed. These tests are carefully instrumented; they are considered successful only when the lunar-capsule system survives the impact and functions throughout all of its perscribed sequence of events.

In short, every reasonable step is being taken by Aeronutronic and the Jet Propulsion Laboratory to assure that the actual lunar landings will, in fact, be mere repetitions of synthesized events already successfully demonstrated many times on Earth. ◆◆

IAF Program

(CONTINUED FROM PAGE 40)

GENERAL PAPERS SESSION

9:00 a.m. **Potomac Ballroom**

Chairman: John L. Barnes, Univ. of California, Los Angeles, Calif.

✦Development of an Equatorial Astronautics Base, Glauco Partel, Societa Italiana Sviluppo Propulsione a Reazione, Rome, Italy.

(Other papers to be announced)

IAF PLENARY SESSION

9:00 a.m. **Georgetown University Institute of Languages and Linguistics**

INSTRUMENTATION ROUNDTABLE

2:30 p.m. **Persian Ballroom I**

Chairman: Henry L. Richter Jr., Electro-Optical Systems, Inc., Pasadena, Calif.

✦Lunar and Planetary Surface Exploration, Ernst Stuhlinger, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Ala.

✦Atmospheric Sampling Instrumentation, Nelson W. Spencer, Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Md.

✦Active and Passive Radar Instrumentation, Walter E. Brown Jr., Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

✦Exo-Biological Instrumentation, George L. Hobby, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

BIOASTRONAUTICS ROUNDTABLE

2:30 p.m. **Potomac Ballroom**

Co-Chairmen: U. S. Von Euler, Karolinska Institutet, Stockholm, Sweden.
Hubertus Strughold, USAF Aerospace Medical Center, Brooks AFB, Tex.

✦Opening Remarks—Definition of Stress, U. S. Von Euler, Karolinska Institutet, Stockholm, Sweden.

✦Homeostatis Compensatory and Failure Patterns in Stress, W. R. Franks, Roya Canadian Air Force, Toronto, Ontario, Canada.

✦Stress Patterns in Animals and Humans Associated with Circadian Rhythms, Colin S. Pittendrigh, Princeton Univ., Princeton N.J., and Jurgen Aschoff, Max Planck Institut fur Verhaltensphysiologie, Seewiesen Post Starnberg, West Germany.

✦Ethnic and Somatological Aspects of Stress Tolerance, D. F. B. Roberts, Oxford Univ., Oxford, England.

✦Motivational, Social, and Cultural Dynamics in Reactions to Stress, David McKenzie Rioch, and Maj. Harold L. Williams, Walter Reed Army Institute of Research, Washington, D.C.

✦The Question of Criteria in Stress Measurement, Loren D. Carlson, Dept. of Physiology, Univ. of Kentucky Medical Center, Lexington, Ky.

✦Summation and Closing Remarks, U. S. Von Euler, Karolinska Institutet, Stockholm, Sweden, and Hubertus Strughold, USAF Aerospace Medical Center, Brooks AFB, Tex.

✦Roundtable Discussion and Discussion from the Floor—Moderated by U. S. Von Euler, Karolinska Institutet, Stockholm, Sweden.

STRUCTURES

2:30 p.m. **Persian Ballroom II**

Chairman: Max L. Williams, California Institute of Technology, Guggenheim Aeronautical Laboratory, Pasadena, Calif.

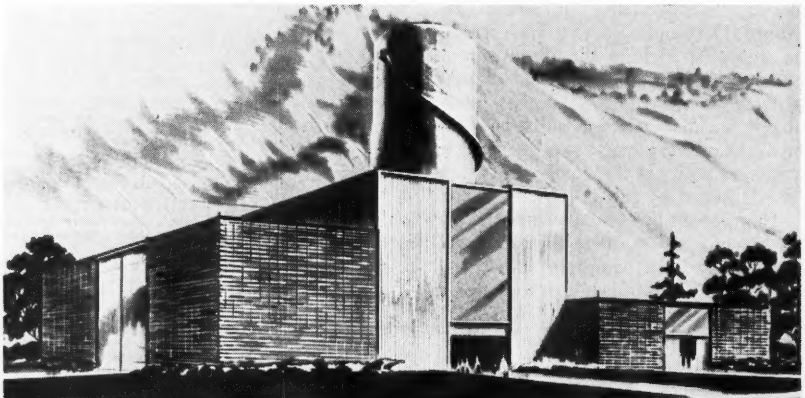
Vice Chairman: Edwin G. Czarnecki, Boeing Co., Seattle, Wash.

✦A Review of Material Problems in Space, L. D. Jaffe and J. B. Rittenhouse, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

✦A review of Unstable Behavior of Thin Shells, Wilhelm Thielemann, Institut Fur Flugzeugbau, Braunschweig, West Germany.

✦A Review of Recent Studies of Crack Propagation, A. J. Murphy, College of Aeronautics, Cranfield, England ◆◆

JPL Building $4 Million Space Simulation Lab

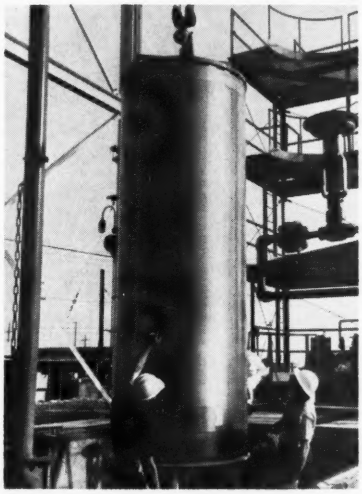


A $4-million space-simulation laboratory is now under construction at NASA's Jet Propulsion Laboratory. The simulator, which will be used to test spacecraft designs, is being built by a team of industrial firms headed by Consolidated Vacuum Corp. and will be completed by the end of the year.

The facility will consist of a 10,000-sq-ft building housing offices, a control room, an equipment area, and the simulator itself. The simulator is a cylindrical tower 80 ft high and 27 ft in diam. Contained within the silo-like structure is a solar simulation unit which can be varied to duplicate the intensity of sunlight a spacecraft might encounter as near to the sun as Venus or as far away as Mars, and a stainless steel vacuum chamber 47 ft high and 25 ft in diam.

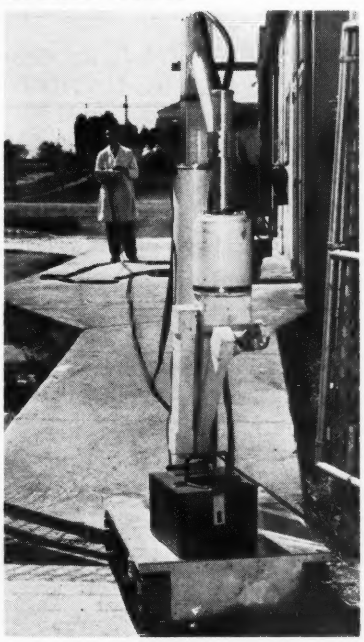
First spacecraft scheduled for testing in the chamber is the Mariner A, which stands 8 ft high and measures 19 ft across with its solar panels extended.

Successfully Test Polaris Glass Fiber Motor Casing

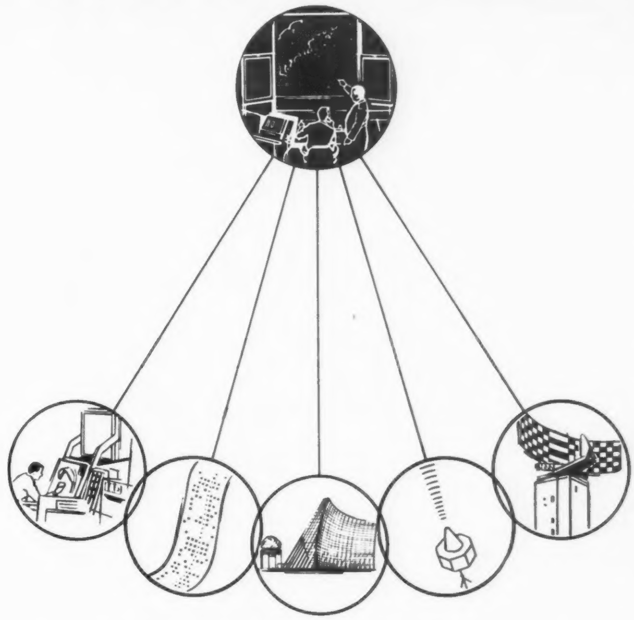


An experimental Polaris rocket motor featuring a one-piece glass-fiber casing has been successfully tested by Aerojet. Three times larger than any glass casing ever used before, the motor was more than 14 ft long and $4^1/_2$ ft in diam.

Rocket Robot



This electronically controlled one-armed robot, latest addition to the Remote Controlled Lab at Thiokol's Elkton (Md.) Div., has taken over many of the dangerous jobs at the lab. Traveling on a wheeled undercarriage and operated from a remote signal box, the robot transports experimental rocket motors and propellant compounds from the lab to the test area.



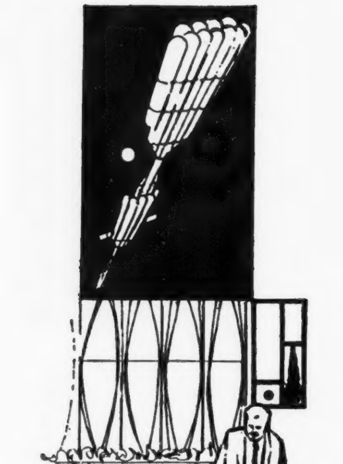
New York Coliseum

October 9-15, 1961

AMERICAN ROCKET SOCIETY

SPACE FLIGHT REPORT

TO THE NATION



Through the medium of the ARS SPACE FLIGHT REPORT TO THE NATION, the American Rocket Society, during the week of October 9-15, 1961, in New York Coliseum will present a thorough and comprehensive review of the U. S. space program.

The SPACE FLIGHT REPORT TO THE NATION will present for the first time under one roof a complete review of the most significant work being done in each of the major technical disciplines contributing to current progress in rocketry, missiles, and space flight, and one of the largest and most extensive technical exhibits ever undertaken in these fields.

More than 300 technical papers will detail major space projects; will explore problems that must be solved to insure further, faster progress; and will stimulate penetrating discussions by outstanding authorities in the audience.

There will be three floors of technical exhibits and displays by more than 350 manufacturers, suppliers, engineering organizations, and governmental agencies, disclosing latest achievements, concepts, products, and ideas.

ARS SPACE FLIGHT REPORT TO THE NATION will present:

- Under one roof, at one time, in one place the most comprehensive review of all the contributing technologies to the U. S. space effort.

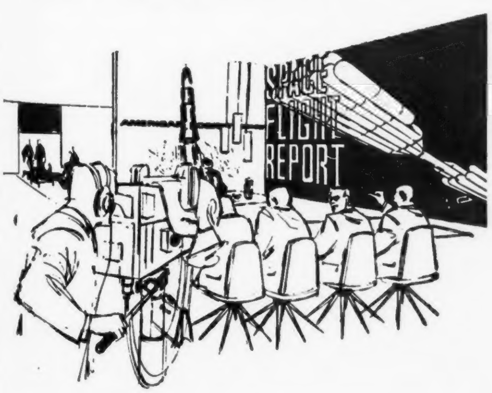
- Forty-two specialized technical sessions, all on the same floor with comfortable lounge areas and conference rooms for informal discussions.

- Three unique Space Flight Report panels that will explore and interpret space missions, space vehicles, and the global impact of space events for the technical community at large.

- A new exhibiting technique called "Exhibiting in Depth", permitting for the first time 3-dimensional displays with the main aisle running *through* the booths instead of by them.

- Main exhibit organized by NASA and DOD, representing U. S. space capability, which will be 88′x50′ in floor area and will extend 60′ into the air.

- The history, purposes, and plans of ARS graphically displayed in a booth designed by Raymond Loewy.



For further information about reservations, program information or exhibit space contact

ARS SPACE FLIGHT REPORT TO THE NATION

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